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NEW YORK, JUNE, 1888.

THE difficulty of controlling a river like the Mississippi is once more shown by the spring floods of the present year. The river is higher now, in its upper course, than it has been for many years, and it has practically destroyed all the levees between the mouth of the Des Moines and the Missouri, including some which have been built with unusual care and at great expense, and which were considered safe against any possible flood. The results have been disastrous, a large extent of very fertile bottom land being overflowed and its value destroyed for the present. The flood has also caused much embarrassment to the railroads, the destruction to embankments and bridges in the overflowed district being considerable and the interruption to traffic serious. The high water has not yet reached the lower river, although some of its southern tributaries, including the Arkansas and the White rivers, are reported as being very full.

A SPECIAL report was recently submitted by the Massachusetts Railroad Commission to the Legislature on the question of heating and lighting passenger cars. The Commission employed Professor Lanza, of the Massachusetts Institute of Technology, to make a careful examination of the various systems of steam-heating and of the difficulties encountered in their operation. An elaborate report submitted by him confirms the Board in the opinion that the system of heating by steam from the locomotive is not only practicable and safe, but is also desirable as a measure of economy, and that it should be adopted as a standard for the State. After considering all the circumstances of the case, and the difficulties to be encountered in making the necessary changes, the Board has decided that there would hardly be time during the present season to change all the cars employed on railroads of the State, and that it would be unreasonable to insist upon the general adoption of any continuous heating system next winter. They have therefore decided, in pursuance of the authority given them by law, to postpone the time when the use of separate heaters will be absolutely forbidden until October, 1889, in the mean time urging the companies to use all reasonable diligence to prepare their cars for steam-heating.

More progress has probably been made toward the adoption of continuous heating systems in Massachusetts than in any other State. The time allowed by the Commissioners is ample, and the railroad companies certainly cannot complain that they are compelled to make the change without sufficient notice.

MENTION has been heretofore made of the rapid progress of railroad consolidation in New England by the absorption of the smaller lines by lease or consolidation. The Boston & Maine is the most conspicuous instance of this; but a later one is the case of the Old Colony Company, which has just completed and rounded out its system by the lease of the Boston & Providence road. There have been some reports that this Company, having thus secured one end of the Shore Line between New York and Boston, would endeavor to strengthen its position by adding to its system the New York, Providence & Boston road, which is an important link in that line, extending from Providence to New London. The advantage of such a lease would have been twofold: The Old Colony would have protected itself against a possible parallel line between Providence and Boston, and at the same time would have secured control of the Stonington Steamboat Line, which is the most important rival of its own steamer line between New York and Boston. Rumors of such a consolidation were prevalent, but they have been contradicted, and the New York, Providence & Boston Company has at the same time asserted its independence and shown its intention to strengthen itself against competition by leasing the Providence & Worcester Railroad. By that lease it secures a line which has important connections, and which controls the business of a large and very active manufacturing district.

This is not the end of consolidation, however, and there are rumors which have, apparently, some basis, that negotiations are pending for the lease of the New York, Providence & Boston to the New York, New Haven & Hartford Company. This is not improbable, although the relations of the two companies are such that a lease would really make little practical difference beyond putting both lines under a single managing head.

THE directors of the Baltimore & Ohio Railroad Company have appointed special committees to examine carefully both the financial and physical condition of its property, and to prepare a plan for a complete reorganization of its management. This is the first result of the change in the control of the company which was brought about last year, and, so far as it goes, it is an excellent one. While the conservative methods of the Baltimore & Ohio were wise in some respects, they have been carried to an extreme, and the road has been, in many points, entirely behind its competitors. It has been controlled, so far as its operating and constructing departments are concerned, by men who looked backward and not forward, with results that have in some cases been disastrous. Then, too, there has always been too much of the one-man power in the management, and subordinate officers have never had

proper authority or responsibility in their own departments, the result being to make them mere machines to record orders from headquarters, and to drive away from the road men who felt themselves capable of doing better. To enumerate all the weak points of the system would take too long, but it is to be hoped that the present opportunity will not be allowed to pass, and that reorganization will be so thorough and so complete as to permit improvement and advance hereafter in the right direction.

One of the first steps taken has been a curtailment of the powers and duties of the office of Purchasing Agent, which have heretofore been curiously and abnormally large on this road.

FRANCE has generally been considered somewhat backward in sanitary science when compared with England or the United States, and the charge is to some extent true. French engineers appreciate this, however, and are doing their best to secure improvement. The paper of M. Mayer on "Sewers," the second number of which will be found elsewhere, is a very interesting one. M. Mayer has studied his subject carefully, and has the French disposition to classify and generalize which is often admirable in an essay of this kind. The paper is written with special reference to the needs of smaller cities, and contains much that will be applicable here as well as in France.

ONE scheme for a new rapid transit line in New York has received a decided set-back, the Supreme Court having decided against the claim of the so-called Metropolitan Transit Company to a right to build an elevated railroad through Broadway. The company's charter provided originally for an entirely different line, but the attempt to build the Broadway route was made under a clause of that charter authorizing certain branches. The Court now holds that, as the main line proposed was never built, the authority to build a branch could not be established, and that in any case a line extending through Broadway from the Battery to Madison Square could not be considered such a branch as the charter referred to. The defeat of this plan will not cause any regret among the people of the city generally.

THE vexed question of the street crossings of the Philadelphia & Reading Railroad in Philadelphia, is probably to be solved by the construction of an elevated railroad from the station at Ninth and Green streets to a point on the outskirts of the city. The new tracks are to be built by an auxiliary company, and an ordinance authorizing their construction is now pending in the City Council. The character of the proposed structure is to be very similar to that of the elevated line by which the Pennsylvania Railroad reaches the Broad Street Station in the same city. Some slight changes in street grades will be required, and also the vacation of some streets, to permit the enlargement of the station. The new line will have four passenger tracks, two of them to be used for the main line traffic and the other two probably for city traffic, local stations to be established at various points. Some modification may be required in the plans as at first submitted in order to meet the views of the City Council and to avoid interference with local interests, but there seems to be little doubt that the elevated line will be built, and that it will be in the end a benefit both to the city and the railroad company.

ANOTHER grade crossing question, which has caused some friction in another part of the country, is also about to meet with a settlement by the construction of a new line for the Boston & Albany Railroad through the city of Springfield, Mass. The road, which now crosses one of the most important streets in that city at grade, is to be raised, and carried over Main Street by a stone arch bridge, and will enter the station at a higher level than at present. This improvement is undertaken in connection with the building of a new station; the change has been agitated for some time, but, as in all such cases, so many interests were to be considered that it was not easy to reach a final agreement.

THE latest addition to the Navy is the little steamer *Stiletto*, which has been purchased by the Navy Department from the builders, the Herreshoff Brothers, for $25,000. The *Stiletto* was built as a steam-yacht and to establish the practicability of certain theories in relation to model and engines. She is one of the fastest vessels of her size ever built, if not the fastest, having attained the extraordinary speed of 23 knots an hour, and having proved her ability to keep up that speed for a considerable length of time. She is only 90 ft. long and 11 ft. beam, with a mean draft of 3 ft. and a displacement of 356 tons. In the Navy the *Stiletto* will be classed as a second-rate torpedo boat, and will be armed and equipped accordingly.

THE cast steel gun made for the Navy by the Pittsburgh Steel Casting Company is now ready to be rifled. The rifling in itself will be somewhat of a test of the condition of the gun, and it will be speedily followed by the firing and endurance tests at the Naval proving grounds. The steel gun cast at Chester will also soon be ready for trial. The tests of these guns, which will come in competition with the built-up guns, which have found favor with Naval officers both here and abroad, will be watched with a great deal of interest.

THE Naval War College, it is stated, is to be discontinued hereafter, on account of the absence of any provision for its expenses. This is to be regretted, for it was without doubt of much benefit to the officers who were able to attend it, and to the service generally. If its methods were open to criticism it would have been much better to amend them than to discontinue the college altogether. Naval science is progressive, and is just now in such a transition state that the young officer who graduates from Annapolis has really only begun the study of his profession.

STEEL turret-forts, which have met with considerable favor with French engineers, and which have been much discussed in military circles in Europe, seem to have failed conspicuously in some recent tests made with the forts at St. Chamond, in France. The forts, in these cases, were built of concrete, the guns being contained in steel turrets, with suitable machinery for lowering them behind the concrete screen when they were not in action, and for raising them when it was necessary to use the gun against an enemy. The concrete resisted projectiles very well, but the steel turret itself suffered very badly, and it was found that the shots not only penetrated and damaged the turrets, but that the steel splinters detached by their impact became

in themselves projectiles capable of inflicting terrible injuries to the men employed in working the guns of the turret. It is true that these tests were made with shots fired at a shorter range than would probably be the case in actual warfare, but they were sufficient, in the judgment of engineers who witnessed them, to show that steel forts were not by any means to be relied upon. The turrets could be sheltered by lowering them behind the concrete shield, but in that position the guns could not be fired, and a fort which merely opposes resistance to the attack of an enemy, but does not possess any power to retaliate, would be of no service, and could be safely ignored by the opposing force.

"NOTES ON STEAM HAMMERS," the first chapters of which will be found on another page, are written, as stated last month, by an eminent French engineer who has had many years' experience in the management of extensive iron works. The work received this year the prize offered by the Society of Alumni of the École Nationale des Arts et Métiers. Our translation is made by special arrangement with M. Chomienne, and from his manuscript, containing a number of additions not found in the French edition as printed.

No standard work on this subject is in existence, and it is hoped that these articles will prove an acceptable addition to engineering literature.

THE War Department is naturally opposed to the Cullom Bill providing for the organization of a new department or bureau for the management of the public works of the United States. In response to a request from the Senate Committee having the matter in charge, Secretary Endicott has submitted reasons why the management of the river and harbor works should be left with the Engineering Corps, which has always had charge of it.

The Council of Engineering Societies, which has been agitating this matter, reports that there is very little doubt that the Cullom Bill will pass the Senate, and will probably meet with very little opposition in the House. In the present condition of the business in the latter body, however, it is to be feared that the bill, if it comes up at all this session, will not meet with the careful consideration which so important a measure should have.

In this connection it may be noted that the bill originated, and has had its main support, among Western engineers. The Eastern members of the profession, while they have not generally opposed it, at least have not been active advocates of the bill, few of them, in fact, having expressed any definite opinion. The majority have apparently regarded it as a matter of small importance, or believed that it was not likely to be adopted.

The most serious objection to the proposed plan seems to be the difficulty of organizing the Bureau at the outset. A large number of new officers are provided for, but there is very great risk that many of the subordinate positions may be filled by incompetent persons, whom it might not be easy to weed out later. Many other objections might be suggested, which there is not room to consider at present.

AN attempt to cross the Atlantic in a balloon is to be made by M. Jovis, a French aeronaut, who claims to have invented machinery for directing the movements of his air ship which will render his attempt a fairly safe one. M. Jovis does not go so far as some previous inventors have done, and assert that he can make himself independent of the wind, but he does claim that he will be able to steer his balloon and utilize the force of the wind very much as can be done in sailing a ship. The attempt will be watched with curiosity, but without much hope of any practical result.

THE Russian Trans-Caspian line is now complete to the ancient city of Samarcand, and was to be formally opened to that point on May 27. The work is still being pushed forward on the extension of the line, and the engineers, it is said, are now engaged in ascertaining whether a branch can be extended northward into Siberia to meet the Pacific line, which is under construction through that country, without encountering too great difficulties.

It is said that the line is receiving an unexpected amount of commercial traffic. It has been built—as our readers will doubtless remember—entirely as a military line for the purpose of supporting the Russian power in Central Asia, but it follows so nearly the routes upon which caravans have traveled for many centuries, that it has naturally attracted to it a trade which will continue to grow, and which will be very considerably increased when the main line reaches its expected terminus at or near the western border of China.

The Siberian Branch, should it be built, will be necessarily more of a military than a commercial line, as it will be a much less direct line to the Amoor settlements and the Pacific than the direct Siberian line, which will be an extension of the Ural Railroad. It might, however, serve to carry petroleum from the Caspian oil region to Siberia, although this is not likely ever to be a very great traffic.

The effect of the railroad on the turbulent nomads, who form the greater part of the population of the country, has been very similar to that which the building of roads across the Plains had upon our own Indians, and from a military point of view it has already proved of inestimable value to the Russians. The moral effect upon the Turkomans—a people especially open to such impressions—of the establishment of an important railroad and military station in their ancient sacred city will be very great.

THE RAILROAD AND ENGINEERING JOURNAL, and with it the "Catechism of the Locomotive," has an established circulation in Europe, Asia, and Africa, as well as in America. To the four continents must now be added the isles of the sea, as is shown by the following extract from a letter received from the Manager of the Hawaiian Railroad with a request for back numbers: "Many of the half-natives in our employ have furnished themselves with your 'Catechism.' This is very flattering to you, for they very seldom, if ever, read—not even stories. It is, perhaps, unnecessary to say that they have been of the greatest help to us."

THE New England Water-Works Association, which is a very lively and active technical society, will hold its annual meeting at Providence, June 13, and the programme shows that the questions which will be brought up for discussion have a very direct and practical bearing upon the interests managed by the members of the Association. The meeting is sure to be an interesting one.

Two important Mexican contracts are now reported let to English parties. One is for the completion of the railroad across the Isthmus of Tehuantepec from Coatzacoalcos on the Gulf to Salina Cruz on the Pacific, on which some work has already been done. The new contractors are to put the partially built section of this line in good order, and finish the line in four years, receiving their pay in bonds, with a large bonus if the work is finished in less time. The railroad is to be State property when completed.

The other contract is for the construction of the Tequixquiac Tunnel, which is to complete the great system of drainage designed for the high plateau upon which the City of Mexico stands. This tunnel is to be 9,250 ft. long, and is to be the outlet for the city sewers, the proper clearing of which has been rendered impossible by the peculiar topography of the city and its surrounding country. About 1,000 ft. of the tunnel have been excavated under a previous contract. The contractors, a London syndicate, are to be paid for the work in city bonds.

The New York aldermen have refused to grant permission for the use of electric cars on the Fourth Avenue line. The opponents of the measure professed to be moved by a tender regard for the personal safety of their constituents, and in debate showed a most profound ignorance as to what the precise danger was, and, indeed, as to everything connected with the system. A New York alderman, however, can usually be trusted to protect the city from everybody and everything except—himself.

THE NEW INTER-OCEANIC CANALS.

TWO of the greatest and most important engineering works now in hand, which are attracting attention not only in this country but abroad, have the same object in view—the providing a navigable channel between the waters of the Atlantic and the Pacific oceans by which vessels may be able to avoid the voyage around the Continent of South America, which is now necessary.

The first of these, the Panama Canal, which crosses, or is to cross, the Isthmus connecting the two Continents at its narrowest part, has been in progress several years, and an enormous amount of money has already been spent upon it. For several reasons, however, chief among which have been the absence at the outset of a proper knowledge of the work to be done and the difficulties to be encountered, and the lack of a thoroughly competent engineering head, this project is just now in serious difficulties. The money which, it was expected, would be sufficient to build it has been raised and spent, and it is still several years from completion, even according to the estimate of its most sanguine advocates. The original plan for a sea-level channel or open cut has been practically abandoned, and its place taken by a canal with locks, which will reduce enormously the amount of excavation required. Even with this concession the time set for its completion will necessarily be postponed for several years beyond that originally appointed, and it is yet uncertain as to whether the company will be able to carry it through; for if the engineers finally succeed in overcoming physical obstacles, there still remains to be faced the difficulty of raising the money required; although there is a bare chance that the pride and ignorance of French investors may make this possible.

The Panama Canal has never been regarded with special favor in the United States, partly because it has been so exclusively a French project and partly because of a lack of confidence in its managers; and the attempt to raise money here for it was an absolute failure. Americans generally look upon the difficulties, or even the prospective failure, of the project with indifference.

The Nicaragua Canal, although it has not yet advanced beyond the stage of a survey and location, possesses more elements of strength. The difficulties to be overcome from an engineering point of view are very much less, and the actual amount of excavation is comparatively smaller; and while the work will be on a sufficiently grand scale, it is still a less costly and much more practical plan than the crossing at Panama. It has been from the beginning an American project, and has met with much favor on this side of the water. At present there seems to be no obstacle in the way of its construction which cannot be overcome, and it is not impossible that vessels may be passing through it from one ocean to the other quite as soon, if not sooner, than through the Panama Canal.

Whatever may be the result as to construction, it seems to us that the projectors of both these enterprises have committed the serious error of largely overestimating the probable traffic which will be attracted to one or both canals, and consequently the financial results which might be expected from them. The calculations which have been made have been based on statistics which are necessarily imperfect and some of them unreliable, and the statisticians (of the Panama Company at least) have evidently been guided in their estimates to a great extent by the figures of traffic for the earlier years of the Suez Canal. Now the business which awaited the opening of that work was much greater in amount than that which waits for the opening of the Panama or the Nicaragua canals, and, moreover, the conditions of ocean traffic have materially changed during the years which have elapsed since vessels first passed between the Mediterranean and the Red Sea.

At that time the advantages gained by shortening the voyage between western Europe and India and China were very much greater from a money point of view than now, and the result of this change has already been felt in a steady and definite falling off in the revenues of the Suez Canal, which has been going on for several years, while at the same time the business has been steadily increasing. The substitution of the triple-expansion marine engine and the use of steam at high pressure for the low-pressure engine, has not only effected a great economy in the consumption of coal, but has also largely reduced the space occupied in a ship by the engines and boilers, leaving more stowage room for cargo. A vessel of the same tonnage and about the same cost can now carry more paying freight and has a wider traffic range—that is, the distance she can steam with such an amount of coal as she can afford to carry is much greater than was the case 20 years ago.

In this way the relative effect of the shortening of a voyage has been diminished, and this is an important element to be taken into account in estimating the prospect of the inter-oceanic canals.

It must be considered that, on the one hand, it will be necessary to charge sufficient rates of toll upon vessels passing through the canal to provide for its maintenance

and other expenses and for moderate interest on its cost. On the other hand, it is necessary that these tolls should not be so high as to keep business away from the canal.

The projectors claim that on voyages between European ports and the western coasts of both North and South America either of the projected canals will save nearly one-half of the length of a steamer trip and considerably more than one-half of its risk. It is evident that the advantages thus gained will be very great. If a steamer carrying wheat from San Francisco, loaded with copper from Valparaiso or nitrates from Peru to Liverpool, can make four trips in a year instead of two, it is manifest that her earning capacity will be doubled with a comparatively small increase of working expenses, for the important element of seamen's wages in the running cost, and the other important items of interest and depreciation would not be increased at all; and from this point of view her owners could afford to pay a considerable amount to the canal and still have a profit left.

The competition for ocean freights, however, is extremely keen and rates are very low, so that ship-owners are compelled to figure very closely; and it would be easy to place the canal tolls at such a point that it would be more profitable for a ship to take the longer and more dangerous voyage. In such a case the effort to secure a proper return upon the cost of the canal would defeat itself by driving away the business which should support it.

If, as we have said, it is probable that an overestimate of the traffic has been made, and that it would be barely sufficient to support and pay interest on a single canal, it is much more likely that if two are built the financial results will be disastrous. In that case there will be a competition for business, and not only will the traffic be divided, but—as some of our railroads have found in similar cases—the rates must be lowered. The business will not only be decreased, but its value will be diminished, and that which might possibly make a return on one of these works would be plainly insufficient to do so on both.

Another source of revenue on which large expectations are based is an expected increase in water traffic between the Atlantic and Pacific coasts of the United States. But this is not to be relied on, for with the railroad competition rates on this business must always be very low, and it is only the heaviest and cheapest class of freight which will go by sea. With this time is not usually an element of any importance, and a very small difference in expense would be enough to send it by a different route than the canal.

With full account taken of all these considerations, it is, however, probable that a single canal will pay after a time, if not at first. Both as an engineering work and a financial undertaking the Nicaragua Canal seems to be the best project, and its success is much to be desired.

NEW PUBLICATIONS.

STATISTICS OF THE AMERICAN AND FOREIGN IRON TRADES FOR 1887: ANNUAL STATISTICAL REPORT OF THE AMERICAN IRON & STEEL ASSOCIATION: JAMES M. SWANK, GENERAL MANAGER. Philadelphia; published by the American Iron & Steel Association.

This report for 1887 contains the usual complete and valuable compendium of statistics which make this publication really indispensable to all who are interested in the iron and steel trade. It covers the most active year in the history of the American iron trade, the output of iron and steel in all their leading forms having been greater than in any previous year. All branches of the trade reported increases, with the single exception of the makers of cut nails, and in this case the reduction is explained and made up by an extraordinary increase in the production of wire nails, which are taking the place of cut nails in the market to a great extent.

While 1887 was a year of unprecedented activity, it was not one of uniform prosperity. The last quarter of the year was marked by a general shrinkage in prices, due to various causes, but largely to a general belief that the general activity, and especially the demand for material for new railroads, could not be kept up much longer. These anticipations have been partly justified by the course of business during the first quarter of 1888.

Mr. Swank, whose position and experience give him exceptional opportunities for forming an opinion, is hopeful of improvement, for he says: "It would not, however, be correct to assume that the first quarter of the new year closes with general depression in our iron and steel industries. The shrinkage in demand is most marked in steel rails, and is next most noticeable in pig iron, bar iron, and wrought-iron pipe. But the consumption of pig iron for miscellaneous purposes is still large, and the steel-rail manufacturers have already entered orders for a large quantity of steel rails, which will be needed in 1888 for renewals and extensions, as well as for some new railroads which must be built. The bridge works of the country, the foundries, the machine shops, the car-builders, and car-wheel makers, the locomotive builders, and many other consumers of iron and steel are still very busy."

THE DESIGN AND CONSTRUCTION OF MASONRY DAMS, GIVING THE METHOD EMPLOYED IN DETERMINING THE PROFILE OF THE QUAKER BRIDGE DAM: BY EDWARD WEGMANN, JR., C.E., DIVISION ENGINEER, NEW CROTON AQUEDUCT, NEW YORK CITY. New York; John Wiley & Sons, 15 Astor Place (price, $5).

The great masonry dams of the world have been mainly built within the last 20 years, and few of them are described in existing works on engineering. Mr. Wegmann's monograph, therefore, fills a gap in engineering literature, and will be very acceptable to those who are interested in the subject. It is based upon the investigations undertaken in connection with the plans and calculations made for the proposed Quaker Bridge Dam, which is to be 270 ft. high, and is to form an immense storage reservoir for the water supply of the city of New York. This will be the highest dam in the world, the nearest to it now in existence being the Furens Dam in France, 171 ft., and the San Mateo Dam in California, 170 ft. high.

The book contains descriptions of a number of masonry dams in this and in foreign countries, and is accompanied by a number of tables giving the details of these structures in a condensed form. There are also a number of plates, giving profiles and other figures in relation to them.

The preface to the book states the motive for its issue as follows: "While the practical importance of the subject of masonry dams seems to be steadily growing, the engineer who may be entrusted with the design of such works will find the theoretical study of the best form of

profile for a masonry dam very disheartening. How widely the types proposed by eminent engineers differ from each other is shown in our frontispiece.

"The theory of masonry dams is based upon a few simple principles and conditions; the mathematics, however, to which they give rise, when applied to the design of an economical profile, are rather appalling. Thus, if we follow the methods of the French engineers, Sazilly and Delocre, we have to solve lengthy equations, some of them of the sixth degree. Moreover, there is always an uncertainty which equation is to be used, and the only way of determining this is by trial. If we wish to employ the method of Professor Rankine, but change the data assumed by him, we have to make trials with the subtangent of a logarithmic curve. In contradistinction to these scientific methods, we find prominent engineers recommending trial calculations as the best practical solution of the problem.

"The writer, . . . after studying the existing methods of designing profiles and finding them for various reasons inapplicable to the case in view, finally arrived at the equations given in this book. They are easy to solve, being, with the exception of one cubic equation, of the first or second degree. The theoretical section of the Quaker Bridge Dam was calculated by these equations."

The book may be accepted as a valuable contribution to engineering literature, in a field heretofore almost unoccupied, and the facts and theories presented are worth careful study.

ABOUT BOOKS AND PERIODICALS.

THE AMERICAN PEOPLE is the title of a new journal which is to be published weekly in Pittsburgh by the National Iron & Steel Publishing Company. The object of the paper is to advocate the continuance of the protective tariff system in the United States. The first number presents an attractive appearance; it is well printed, well edited, and contains a variety of matter calculated to appeal to and attract readers of all classes.

The first of the series of railroad articles in SCRIBNER'S MAGAZINE appears in the June number, and is on the Building of a Railway, by Thomas Curtis Clarke. Mr. Clarke's article gives a general description of the methods used in the location and building of a railroad, and is also largely historical, relating what has been done in the past, and giving some instances of the difficulties encountered and overcome in the construction of railroads. It contains a large number of illustrations, some of which are very well done, and give striking examples of railroad work.

The next article—on Engineering Feats—which will appear in the July number, will be by Mr. John Bogart.

In NEW YORK RAILROAD MEN for May is begun a series of articles on the railroad books in the Railroad Men's building at 361 Madison Avenue. The first one, on General Works, by James Egan, is brief, as general works on railroads are few. The mechanical and technical works will be discussed in the next issue of the paper, in June.

The article on "What to Read" ought to serve as a guide to the uninitiated; the article on "Books and Character" impresses us with the fact that "Man's character is very largely shaped by the books he reads," and that the man who reads on railroading will become a valuable man to the company.

Among the new books now in preparation by Messrs. John Wiley & Sons which will shortly be published are: A TREATISE ON HYDRAULICS, by PROFESSOR MANSFIELD MERRIMAN, which is designed both for the use of engineers and as a text-book for technical schools; DESCRIPTIVE GEOMETRY, by PROFESSOR SOLOMON WOOLF; ROCKS AND SOIL: A TREATISE ON THE CHEMISTRY OF GEOLOGIC TRANSFORMATIONS AND SOIL COMPOSITION, by DR. H. E. STOCKBRIDGE, of the Japanese Imperial College of Agriculture; MICROSCOPIC PHYSIOGRAPHY OF MINERALS AND ROCKS, by PROFESSOR H. ROSENBUSCH, translated by JOSEPH P. IDDINGS of the United States Geological Survey. This last-named work will be profusely illustrated.

LIEUTENANT BRADLEY A. FISKE, who is well known to our readers, has a paper in a recent number of the *Army and Navy Journal* on the use of electric motors for naval and military purposes. Lieutenant Fiske presents very strongly the advantages of electric motors for use in ships and forts over steam engines; and also over pneumatic and hydraulic engines, claiming that they are more simple, more quiet, more clean, require less attention, and are more easily controlled; moreover, wires take less room than steam or water pipes on board the ship, and being very much smaller than pipes are less liable to be struck, while they have the further advantage that if an electric wire should be cut by a shot it can be very quickly and easily repaired, and there will be no escape of steam or water, as when pipes are broken. There is a still further advantage that, with a central dynamo with main wires leading through the ship or fort, small motors for different purposes, such as hoisting ammunition, working guns, etc., etc., can be placed wherever they are most convenient for use and can be worked from a central station. Lieutenant Fiske presents his arguments admirably, and his paper is well worth reading.

An INDEX OF ENGINEERING ARTICLES contained in leading periodicals for the five years 1883–87, inclusive, has been prepared by Mr. Francis E. Galloupe, M.E., who purposes publishing it, provided a sufficient number of subscribers can be obtained. The periodicals included in *Index* are: *Engineering News; Iron Age; Mechanics; American Engineer; Engineering and Building Record; Railroad Gazette; Van Nostrand's;* RAILROAD AND ENGINEERING JOURNAL; *Journal of Franklin Institute; Street Railway Gazette; Electrician; Electrical Review; Electrical World; Scientific American Supplement; The Locomotive; Society of Arts Proceedings; Engineering* (London); *The Engineer* (London).

Mr. Galloupe's prospectus says: "The work, which is now ready for the press, contains upward of 10,000 carefully selected references, arranged in a single alphabetical index by subjects, covering information now only to be extracted by the aid of some 150 different indices, and is designed to make accessible to engineers in all branches of the profession, to special investigators, librarians, editors and others, such information without loss of time."

There can be no question that such a work will be of very great service to engineers. Much of the best engineering literature is contained in the various periodicals, and it is often a work requiring so much time to hunt up the article wanted that it is practically impossible to do it. The cost of the *Index* will be $2, and persons wishing to

subscribe can address Mr. Galloupe at No. 30 Kilby Street, Boston.

BOOKS RECEIVED.

SOME THOUGHTS AND SUGGESTIONS ON TECHNICAL EDUCATION: BY PROFESSOR T. EGLESTON, PH.D. New York; published by the Author. This is a reprint of the Presidential address made by Professor Egleston before the American Institute of Mining Engineers at the Boston meeting in February last.

STEAM AND ITS RIVALS: BY PROFESSOR R. H. THURSTON. Reprinted from the *Forum*.

INSTITUTION OF MECHANICAL ENGINEERS: PROCEEDINGS, FEBRUARY, 1888. London, England; published by the Institution.

REPORT ON THE RELATION OF RAILROADS TO FOREST SUPPLIES AND FORESTRY, WITH APPENDICES ON THE STRUCTURE, BEHAVIOR, AND CAUSES OF DECAY OF SOME TIMBER TIES; ON WOOD PRESERVATION; ON METAL TIES; AND ON THE USE OF SPARK ARRESTERS: COMPILED BY THE CHIEF OF THE FORESTRY DIVISION, DEPARTMENT OF AGRICULTURE. Washington; Government Printing Office.

INTERNAL COMMERCE OF THE UNITED STATES: 1887. SPECIAL REPORT ON THE COMMERCE OF THE MISSISSIPPI, OHIO, AND OTHER RIVERS, AND OF THE BRIDGES WHICH CROSS THEM. WILLIAM F. SWITZLER, CHIEF OF THE BUREAU OF STATISTICS, TREASURY DEPARTMENT. Washington; Government Printing Office. This is Part II of the report on Commerce and Navigation for 1887.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS: BOSTON MEETING, FEBRUARY, 1888. New York; issued by the Institute.

SOME APPLICATIONS OF GRAPHICAL STATICS: BY JAMES R WILLETT. Chicago; *Inland Architect* Press. This is a reprint of a very interesting paper read before the Chicago Chapter of the American Institute of Architects by the Author.

FIFTH ANNUAL REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF NEW YORK, FOR THE YEAR ENDING SEPTEMBER 30, 1887; VOLUME II: WILLIAM E. ROGERS, ISAAC V. BAKER, JR., MICHAEL RICKARD, COMMISSIONERS. Albany, N. Y.; State Printers.

ELEVENTH ANNUAL REPORT OF THE RAILROAD COMMISSIONER OF THE STATE OF VIRGINIA, FOR THE YEAR 1887: J. C. HILL, COMMISSIONER. Richmond, Va.; State Printing Office.

STEAM BOILERS PRACTICALLY CONSIDERED. St. Louis, Mo.; issued by the Pond Engineering Company, No. 707 Market Street.

PAPERS READ BEFORE THE ENGINEERING SOCIETY OF THE SCHOOL OF PRACTICAL SCIENCE, TORONTO: NUMBER 2. Toronto, Ont.; printed for the Society. This, the second yearly number, contains papers on Rodding on Railroad Work, by G. H. Richardson; Explorations on Battle River, by H. G. Tyrrell; Mortars and Cements, by A. L. McCulloch; Railroad Surveys, by A. R. Raymer; Petroleum, by W. J. Withrow; Notes on Iron Bridge Building, by E. W. Stern; Angle Blocks, by T. K. Thomson; Transition Curves, by J. L. Allison.

OCCASIONAL PAPERS OF THE INSTITUTION OF CIVIL ENGINEERS. London, England; published by the Institution. The present installment of these papers includes the Castletown Swing Bridge, by Charles Wawn; the Alexandria Dock, Hull, by Arthur Cameron Hurtzig; a Covered Way, as Constructed on the Glasgow City Railway, by Walter Stuart Wilson; the Electrical Tramway in Hamburg, by J. L. Huber; Use and Testing of Open-hearth Steel for Boiler Making, by Hamilton Goodall; Autographic Drifting Tests, by John Goodman; Experiment with a Steam Exhauster or Blower, by George Brunton; the Hooghly Jubilee Bridge, by Sir Bradford Leslie; Improved Systems of Chaining for Surveys, by William Mann Thompson.

An additional installment of these papers received includes the following: River Gauging at the Vyrnwy Reservoir, by John Henry Parkin; Classification of Continuous Railway Brakes, by Arthur Wharton Metcalfe; Alignment of the Nepean Tunnel, New South Wales, by Thomas William Keele; Mining Appliances in Westphalia, by MM. Malhet, de Gournay, and Suisse, translated by William Silver Hall; Heating Carriages by Exhaust Steam on the Caledonian Railway, by Dugald Drummond; Boiler Experiments and Fuel Economy, by John Holliday; Economic Use of the Plane Table in Topographical Surveying, by Josiah Pierce, Jr.; Dipping or Fog Apparatus for Electric Light in Lighthouses, by Charles Alexander Stevenson; Abstract of Papers in Foreign Transactions and Periodicals.

ANNUAL REPORT OF THE SECRETARY OF INTERNAL AFFAIRS OF THE COMMONWEALTH OF PENNSYLVANIA: PART IV; RAILROAD, CANAL AND TELEGRAPH COMPANIES, FOR THE YEAR 1886. THOMAS J. STEWART, SECRETARY. Harrisburg, Pa.; State Printer.

THE DESIGNING AND CONSTRUCTION OF STORAGE RESERVOIRS: BY ARTHUR JACOB. REVISED AND EXTENDED BY E. SHERMAN GOULD. SCIENCE SERIES, NO. 6. New York; D. Van Nostrand, 23 Murray Street. (Price, 50 cents.)

AMERICAN STREET RAILWAY ASSOCIATION: REPORT OF THE SIXTH ANNUAL MEETING, HELD IN PHILADELPHIA, OCTOBER 19 AND 20, 1887. Brooklyn, N. Y.; issued by the Association; W. J. Richardson, Secretary.

THE AMERICAN ECONOMIC RAILWAY, MANSFIELD SYSTEM (GAUGE 2 FT.): BY GEORGE E. MANSFIELD. Boston, Mass.; published by the Author.

THE OFFICIAL RAILWAY LIST: 1888. Chicago, Ill.; published by the Railway Purchasing Agent Company, No. 95 Adams Express Building. This is the seventh year of this very useful publication, which is a directory of the railroad officers of the United States and Canada, corrected yearly.

COMBINATIONS: THEIR USES AND ABUSES; WITH A HISTORY OF THE STANDARD OIL TRUST: BY S. C. T. DODD, SOLICITOR OF THE STANDARD OIL TRUST. New York. This is a reprint of the argument made by Mr. Dodd before the Committee of the New York Senate, in relation to bills pending before the Legislature.

AUTOMATIC FIRE SPRINKLERS: A TEXT BOOK. New York; issued by the Edward Barr Company, Limited, No. 78 John Street.

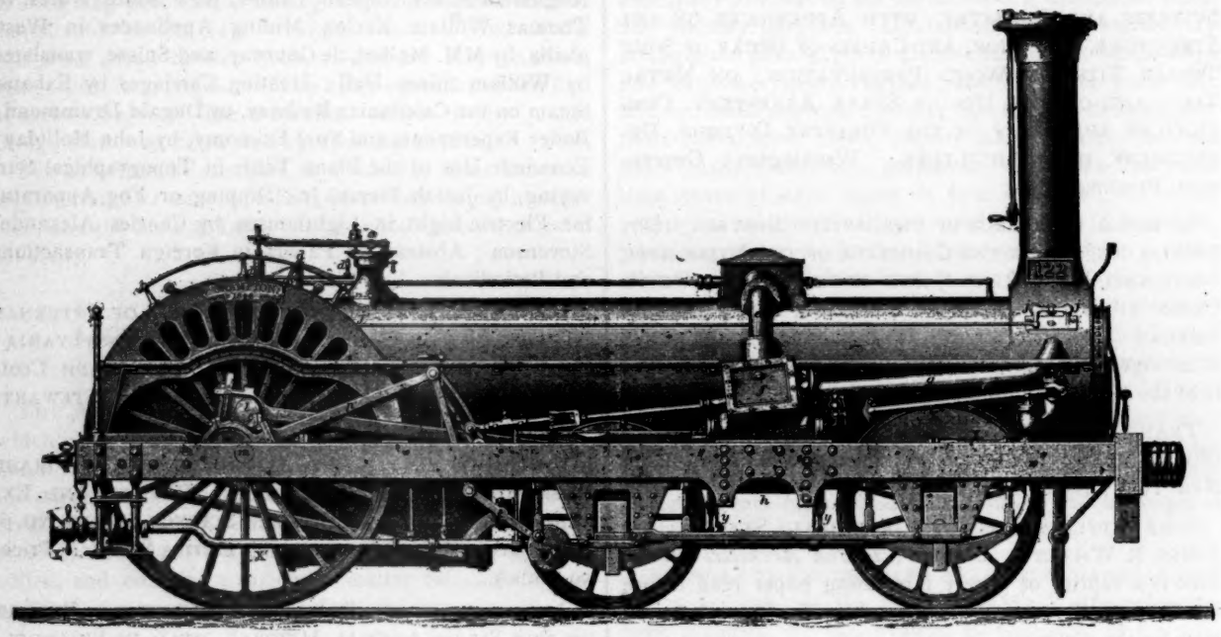
AUTOMATIC CUT-OFF STEAM ENGINES: CATALOGUE. Erie, Pa.; issued by the Erie City Iron Works.

VREELAND'S PATENT TRANSFER JACK: CATALOGUE AND DESCRIPTION. New York; Watson & Stillman, 210 East 43d Street. This is a description of a very handy jack intended for use in round-houses and erecting shops.

CHALLENGE EMERY GRINDING AND POLISHING MACHINERY: CATALOGUE. New York; issued by the Prentiss Tool & Supply Company, No. 42 Dey Street.

The Crampton Locomotive.

THE recent death of Mr. Thomas Russell Crampton recalls attention to the Crampton locomotive, which was designed some 40 years ago for fast passenger service, and of which high expectations were then entertained. It may therefore be of interest to our readers to recall what were the characteristics of this engine.



THE CRAMPTON LOCOMOTIVE.

As shown in the accompanying illustration, which is reproduced from an old engraving, the distinguishing features of the Crampton engine were a long boiler, very large driving-wheels, and a low center of gravity. To secure the last-named object outside cylinders were used, and all the valve gear was also placed outside, the boiler being brought down as close to the axles as possible.

This engine was much discussed in England, but was never adopted to any considerable extent on the railroads of that country. Where it did come into use its obvious disadvantages as a locomotive for heavy work led to its gradual abandonment as passenger service grew harder, and it has been replaced by engines which have gradually approached the American type.

In France, however, the Crampton engine was adopted by several of the great railroad companies and was extensively used. While it has, in that country also, passed out of use to a considerable degree, its influence is still perceptible in the general design of the passenger engines in service on French railroads.

Modern practice favors only one point of Mr. Crampton's design, the outside cylinders, and the engine is now of interest chiefly to show what was considered desirable by an engineer of high repute in the earlier days of railroads.

Pope's "Flying Pendant Lever Bridge."

To the Editor of the Railroad and Engineering Journal:

In your May number I note a review of the "Treatise on Bridge Architecture," by T. Pope, 1811. You say that you "are not aware that Mr. Pope's arguments, however, were successful in convincing the capitalists of his day, and, so far as we know, no bridge on the 'Flying Pendant Lever' plan was ever actually constructed, even on a small scale."

This is hardly fair treatment of Mr. Pope. Turn to page 278 of his treatise, and read the description of the "Grand Model" actually built, a half-bridge on a scale of $\frac{3}{8}$ in. to one foot: "The length of model of half-bridge, in real measure, is nearly 50 ft. The weight that the unsupported arm of this diminutive model bore at one time, since finished, has been 10 tons."

Have we an engineer to-day who, with Mr. Pope's material and facilities, can do better? I trow not. Our improvement since that date has been more in metallurgy than in men.

The writer knows one eye-witness of the "Grand Model" whom he believes to be still living in Hoboken, and who described the model clearly, but could not tell the name of the man who made it.

Such is fame. ALOHA VIVARTTAS.

New York, May 3, 1888.

[It was not intended to deprive Mr. Pope of any credit justly belonging to him. The statement made in the article to which Mr. Vivarttas refers was intended to apply to bridges built for actual service. Mr. Pope was probably in advance of the age in his theories, though somewhat lacking, apparently, in practical experience.—EDITOR RAILROAD AND ENGINEERING JOURNAL.]

THE PRINCIPLES OF RAILROAD LOCATION.

By Professor C. D. Jameson.

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(*Continued from page* 205.)

CHAPTER XXI.

TRANSITION CURVES.

The object of the use of transition curves in locating and building a line of railroad is to make the change in direction from a straight line to a curve of a given radius less abrupt and sudden than when the required curve joins directly with the straight line.

This is accomplished by leaving the straight line on a curve whose radius approaches infinity, and gradually decreasing this radius until it becomes equal to the radius of the required curve.

Thus, in Plate XLIII, fig. 1, let *A B* be the tangent and *D C* the required curve. When *D C* joins the tangent at

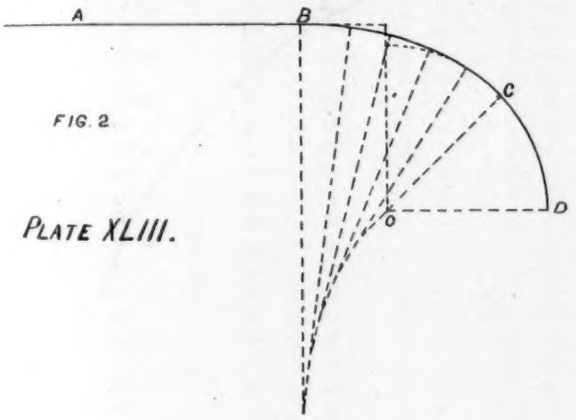


FIG. 2

PLATE XLIII.

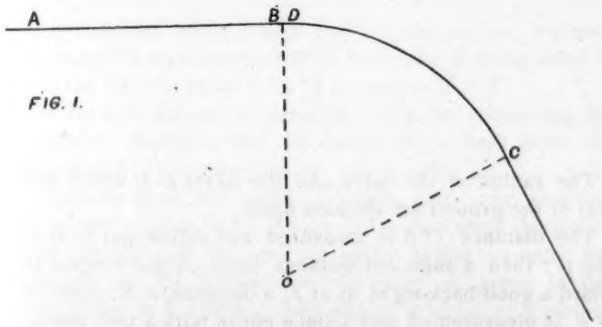


FIG. 1.

B, the change of direction is more or less abrupt, depending upon the radius of the curve *D C*.

This change of direction is very perceptible in a train running at a moderate or high rate of speed, and produces a certain amount of wear and tear on the rolling stock and track and also increases the amount of resistance opposed to the movement of trains.

Transition curves do away to a great extent with this jar given to trains, and the wear and tear to rolling stock and track, and to some extent reduce the resistance due to the curve, thus diminishing the evil effects of curves and permitting the use of curves of a shorter radius.

Moreover, by the use of transition curves a railroad line can be fitted much more accurately to the ground, as the contour of hills, etc., and the general configuration of the ground are found in most cases to change gradually and therefore to conform more nearly with a line made up of tangents, transition curves, and circular curves than one where the required circular curve is joined directly to the tangent. In Plate XLIII, fig. 2, let *A B* be the tangent and *C D* the required curve; then in place of joining the curve directly upon *A B*, we leave *A B* with a curve whose radius approaches infinity, and as we approach *C* we gradually decrease this radius until some point *C* is reached where the radius of this transition curve equals the radius of the required circular curve *C D*.

The circular curve *C D* is then run in for the required distance and joined to the following tangent by means of another curve similar to *B C*.

The curve *B C* which most nearly approaches the one required by theory for the transition curve is the cubic parabola and some spirals that nearly coincide with it.

Now, in order to make these curves of practical use, it must be possible to run them in in the field with no more difficulty than an ordinary circular curve, and this to a certain extent is not possible when the cubic parabola or spirals are used.

The whole principle of the transition curve is as follows: In Plate XLIV, let *A B* be the tangent and *D E F* the required circular curve.

Now, what is done in reality, no matter what method, formula, or curve is used, is that the curve *D E F* is moved in a certain distance, *D B*, from the tangent or the radius of this curve shortened by the distance *D B*; that *B*, the point of tangent (P. T.), is moved back from *B* to *A* a certain distance, and that the part *D E* of the circular curve is replaced by *C E* of the transition curve, the transition curve passing through the point *C*, which is half-way between *B* and *D*.

In using the cubic parabola or a spiral, the distance *D B* is determined by the radius of the curve *D E F*, and cannot be changed unless the spiral is changed, which necessitates either a great number of tables or a long complicated calculation with each curve, which is not admissible in the field.

When any method is used which absolutely fixes the length of the offset *D B*, the line when run in on the ground is as rigid and unyielding as if no transition curve had been used—that is, no part of it can be moved to fit it more closely to the special formation of the ground at that point without the preceding and following portions of the line also being changed, thus necessitating much additional work, and in the end a much less accurate fitting of the line to the ground.

Therefore another object to be sought for by means of the transition curve is the rendering of the line *elastic* to a certain extent—that is, so arranging the connection between the circular curve and the tangent by means of the transition curve, that the circular curve *D E F* can be moved back and forth to one side or the other (always, of course, within certain limits) and the connection between it and the tangents still be accurately made without in any way affecting the position of the tangents more than increasing or decreasing their lengths to a slight extent, as the case may be.

The following method, although it may appear crude, and certainly is not theoretically correct, is accurate enough for all practical purposes, and has the advantage over all others known to the author of making an elastic line

which may be fitted accurately to the ground and any part of it changed at any time within certain limits without necessitating the changing the location of any other part of the line.

The offsets $B\,D$ of the circular curve from the tangent are taken anywhere from 4 ft. to 20 ft., or even a greater distance, if necessary.

In Plate XLIV let $A\,B$ be the tangent and $D\,B$ any desirable offset (its length depending upon the contour of the ground in each particular case) of the circular curve $D\,E\,F$ from the tangent. The transition curve connecting the tangent and this circular curve must pass through the point C, half-way between B and D. Then the conditions necessary, for a transition curve are complied with, with all necessary accuracy, by introducing a curve $A\,h\,C\,m\,E$, to which $A\,B$ shall be tangent, which shall pass through the point C ($C\,D = \frac{1}{2}\,B\,D$) and which shall be tangent to the circular curve $D\,E\,F$.

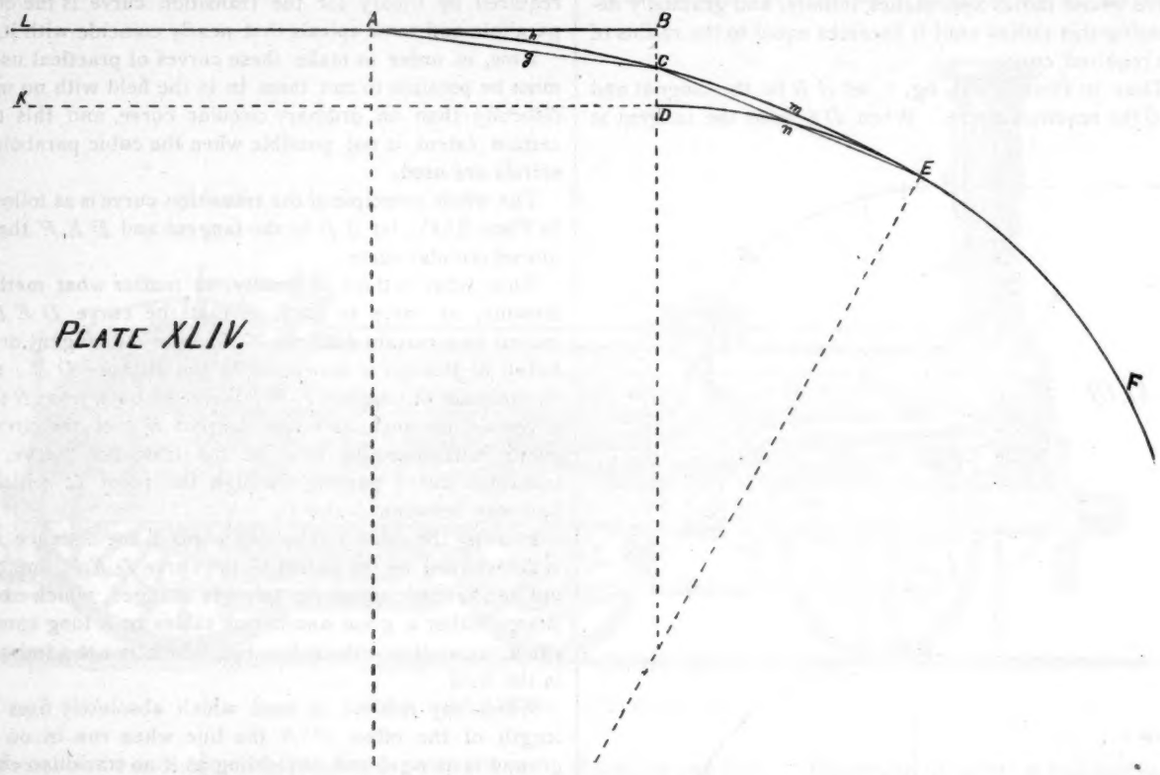


PLATE XLIV.

The curve $A\,h\,C\,m\,E$ is not, of course, a theoretical transition curve; it is of the same radius throughout, and is simply a curve with a radius larger than that of the circular curve, and connecting the circular curve with the tangent.

The accompanying table (which is numbered as Plate XLV) contains all the required data for running in transition curves of the above-mentioned type. In this table column 1 contains the degree of curvature of the circular curve, the chords subtending this angle being 100 ft. long.

Column 2 contains the radii of the curves.

Columns 3, 5, 7, 9 to 19 contain the distances $A\,B$ and $D\,E$ (Plate XLIV) for curves of different radii and offsets of different lengths. The numbers at the head of the columns are one-half $D\,B$ or $C\,B$.

Columns 4, 6, 8, 10 to 20 contain the offsets from the chords $A\,g\,C$ and $C\,m\,E$ connecting the points $A\,C$ and $C\,E$.

The points on the chords where these offsets are taken are 100 ft. or 200 ft. from C either way, and the offset is always measured toward the outside of the curve, as $g\,h$ and $n\,m$. The distances $A\,B$ and $D\,E$ have been considered equal. This is not actually the case, however, $A\,B$ being nearly equal to $C\,E$, and $C\,E$ a trifle longer than $D\,E$. The difference, however, is so slight that it may be entirely disregarded. Within the limits laid down in the table, the greatest difference between $A\,B$ and $D\,E$ is when the circular curve is 16° 30′ and the offset $D\,B$ 20 ft., and even in this case it is only 2 ft., which distance would not in any way affect the practical accuracy of the curve $A\,g\,C\,m\,E$.

The manner of running in these curves is as follows: The tangent $A\,B$ is run up to any point, as B, where, from the configuration of the ground, it is deemed advisable to introduce a curve.

The radius of the curve and the offset $D\,B$ which will best fit the ground are decided upon.

The distance $D\,B$ is measured and stakes put in at D and C; then a sufficient distance back on the tangent to afford a good back-sight, as at L, a distance, $L\,K$, equal to $D\,B$, is measured off and a stake put in with a tack point.

The transit is set up at D and sighted on K, the telescope then reversed and the circular curve run in. This curve is continued until it is deemed necessary to run off on a tangent, when *any* required offset is taken and the tangent run in. Until the line is being staked out for construction to commence there is no absolute need of running in the transition curves. When, however, it is desired to put them in we find in column 1 of the table the degree of curvature of the circular curve. Then following this row of figures across the page until we come to the vertical column which has $C\,D = \frac{1}{2}\,B\,D$, $B\,D$ being the offset from the tangent which has been taken, and in this column and opposite the radius we will find the transition distances $A\,B$ and $D\,E$ in feet. This distance is

PLATE XLV.

TABLE FOR LAYING OUT "TRANSITION CURVES," WITH OFFSETS OF DIFFERENT LENGTHS, WITH CIRCULAR CURVES OF DIFFERENT RADII.

(*Letters of reference in this Table refer to Plate XLIV.*)

1. Degree of Curvature.	2. Radius.	3. *c d* 2.	4. *m n* or *g h*.	5. *c d* 3.	6. *m n* or *g h*.	7. *c d* 4.	8. *m n* or *g h*.	9. *c d* 5.	10. *m n* or *g h*.	11. *c d* 6.	12. *m n* or *g h*.	13. *c d* 7.	14. *m n* or *g h*.	15. *c d* 8.	16. *m n* or *g h*.	17. *c d* 9.	18. *m n* or *g h*.	19. *c d* 10.	20. *m n* or *g h*.
3°	1,910	123	0.3	151	0.7	175	1 0	196	1.2	214	1.5	231	1.7 0.8	247	1 9 1.3	262	2.1 1.6	277	2.3 2.0
3° 30′	1,637	114	....	142	0.6	162	0.9	181	1.2	198	1.5	214	1 7 0.4	229	2.0 0.9	243	2.2 1.2	256	2.4 1.8
4°	1,433	107	....	131	0.5	151	0.9	169	1.2	185	....	200	1.7	214	2.0	227	2.2 1.0	240	2.4 1 4
4° 30′	1,273	101	0.2	123	0.4	143	0 8	160	1 1	175	1.5	189	1.7	202	2.0	214	2.2	226	2.4 1.2
5°	1,146	96	....	117	....	135	....	151	1.1	166	....	180	1.7	192	2.0	203	2.2	214	2.5 0.8
5° 30′	1,042	91	...	111	0.2	129	0.7	144	....	158	1.4	171	1.7	183	2.0	194	2.2	205	....
6°	955	87	....	107	....	124	....	139	1.0	152	1.3	164	1.6	175	....	186	....	196	2.5
6° 30′	881	84	....	103	....	119	0.6	133	....	146	....	157	.. .	168	1.9	178	2.2	188	2.5
7°	819	81	....	99	0.2	115	....	128	0.9	140	1.2	151	1.5	162	1.8	172	2.2	181	2.5
7° 30′	764	78	....	96	....	111	0.3	123	....	135	..	146	....	157	....	166	....	175	....
8°	716	76	....	93	....	107	....	119	0.7	131	1.0	142	....	152	1.7	161	2.1	170	2.4
8° 30′	674	73	....	90	....	104	....	116	....	127	....	138	1.4	147	....	156	....	165	....
9°	637	71	....	87	...	101	0.1	113	..	124	....	134	....	143	....	152	2.0	160	2.3
9° 30′	603	69	....	85	....	98	....	110	0.4	121	0.8	131	1.2	139	1.6	148	....	156	....
10°	574	68	....	83	....	96	....	107	....	118	....	128	....	136	....	144	....	152	2.2
10° 30′	546	66	....	81	. ..	93	....	104	....	115	....	124	...	133	...	141	1.8	148	....
11°	522	65	...	79	....	91	....	102	....	112	....	121	0.9	130	1.4	138	...	145	....
11° 30′	499	63	....	77	....	89	....	100	0.2	110	0.5	118	....	127	....	135	.. .	142	....
12°	478	62	....	76	....	88	....	98	...	108	..	117	....	124	....	132	....	139	2.0
12° 30′	459	60	....	74	....	86	....	96	....	105	....	114	...	121	....	129	1.6	136	...
13°	441	59	....	72	...	84	....	94	....	103	....	111	....	119	1.1	127	....	134	....
13° 30′	425	58	....	71	....	82	....	92	....	101	....	109	0.6	117	....	124	....	131	1.8
14°	410	57	...	70	...	81	....	91	....	99	0.2	107	....	115	....	122	....	129	....
14° 30′	396	56	.. .	68	....	79	....	89	....	97	....	105	....	113	....	120	1.2	127	...
15°	383	55	....	67	. ..	78	....	88	....	96	....	104	....	111	0.6	118	....	125	...
15° 30′	370	54	....	66	....	77	....	86	....	94	...	102	....	109	....	116	....	123	....
16°	359	54	....	66	....	76	....	85	....	93	. .	101	....	108	.. .	115	....	121	1.4
16° 30′	348	53	....	65	....	75	.. .	84	....	91	....	100	0.3	106	0.3	113	0.7	119	1.4

measured back from *B* to *A* and a stake put in; it is also measured forward from *D* to *E*, the stake *E* being lined in with the transit, so as to be in the curve *D E F*.

In the next column to the right of the one containing the transition distance will be found the offsets from the chords *A g C* and *C n E* to the curve *A h C m E*.

Measure from the point *C* 100 ft. each way, and line these two points in by the eye, and then from the points thus found, and as near at right angles as may be, measure off the distance of the offset as given in the table under *m n* and *g h*, and put in a stake at *h* and *m*. When the transition distance is more than 200 ft., the table contains two offsets—one 100 ft. from *C* and the other 200 ft.

At any time the position of the curve or the tangents may be changed within certain limits without changing any other part of the line.

1. The radius can be shortened until the actual length of the curve is equal to the transition distance *D E* at one end, *plus* the transition distance at the other.

2. The radius can be increased until the offset *B D* becomes 4 ft., unless the radius is equal to or greater than 1,910 ft., when it can be increased until *D B* = 0 and *D* coincides with *B* and all necessity for a transition curve is done away with.

3. The curve or the tangent can be moved in any direction, provided always the distance *D B* at either end of the curve does not become less than the minimum distance allowed, or that the transition distance *D E* at one end of the curve *plus D E* at the other end of the curve does not become greater than the total length of the curve.

CHAPTER XXII.

GRADES.

One thing, above all others, upon which depends the future success of a railroad, from a financial standpoint, is the economical establishment of the GRADES in detail. This, of course, is determined to a great extent by the character of the country through which the railroad is to be built, but in any class of country and whatever the surface and profile that a line may have, there is always one system of grades which is pre-eminently better than any other, and it is the duty of the engineer to find that system.

The GRADES of a road are usually of much more importance than the CURVES. This is not due to any inherent evil in the grades themselves, but rather to the fact that, owing to the configuration of the country, the grades limit the amount of load that can be hauled by one locomotive. That is, the resistance due to the grade is the limit of the amount of work which can be done by one locomotive. Of course, if the configuration of the country should be

such that the resistance due to the curves exceeds that due to the grades, then the resistance due to the curves becomes the limiting power, and the general order of things is reversed. To the knowledge of the writer, however, there is only one railroad in the United States in which this happens; that is the Hudson River Railroad, where, owing to the exceptional character of the country, the curves are of necessity very sharp and the grades comparatively nothing, so that the resistance due to the curves far exceeds that due to the grades, and the curves become the limiting element of the amount of work that can be done by a locomotive. This resistance due to the grades is not in itself so bad, but is bad simply from the fact that, as the locomotive is now built, the limit of its power, and thus the limit of the possible load, is very soon reached; but if the time ever comes that some new motive power is discovered by means of which the power can be greatly increased when necessary and not lost when unnecessary, then much of the present evil due to grades will be done away with.

Before going into the question of the rate of grade and the economical problems concerning the future operating expenses, we wish to call attention to some considerations in regard to the cost of construction. It is stated by most writers that the grade line should be such that the cuts will balance the fills, so that the material excavated will serve to make embankments, but there are many things to be considered in this connection.

In Plate XLVI, fig. 1, let *A* represent a cut and *B* a fill. Where the land is of little value and material may be obtained without paying any land-damages for earth borrowed from the side of the line, then the cost of the haul from *A* becomes very soon greater than the cost of loosening and hauling from the side of the fill, and it is economy to waste the excavation and make the embankment *B* from material borrowed from the side. Where the land is valuable, in a thickly settled country, the economical length of the haul will be much greater. As the length of the haul increases the cost of excavation increases very fast, and very soon exceeds the cost of wasting the excavation and borrowing the material to make the fill. Of course the question of the cost of wasting and borrowing, as compared with making the fills from the excavation, is more properly a question to be studied in detail under the head of construction, and the locating engineer has only to consider it in its larger and more general features.

This question must be studied with care in each case, and will be taken up more in detail in a chapter on the Calculation and Estimate of Earth-work.

CHAPTER XXIII.

RATE OF GRADE.

By the RATE OF GRADE is meant the angle which the grade line of a road forms with the horizontal. This angle is very seldom given in angular measurement—that is, in degrees and minutes—but usually in so many feet of vertical rise to a certain length horizontal. Thus it may either be given in so many feet rise to 100 ft, horizontal, as a grade 4 ft. rise to 100 ft. horizontal, or a 4 per cent. grade, as it is called, or as so many feet to the mile, as 52.8 ft. rise per 1 mile horizontal—that is, a 1 per cent. grade. English engineers very often give it in the shape of 1 ft. rise to so many horizontal, as 1 ft. in 80 or 90 ft.—that is, 1 ft. rise to 80 or 90 ft. horizontal. There are very many objections to this last method, and by far the best way is to give it in so many feet to the hundred or its per cent.

As we have stated before, the grades are of much more importance to a road than the curves, as they constitute the limiting power as to the amount of work which can be done by one locomotive. Another reason for their superior importance over curves is that any increase in length of line due to curvature is not an entire loss to the railroad, as the public seem perfectly willing to pay an additional sum for being carried around a large curve where they would not pay a cent more for going up and down a steep grade which would save them distance, or through a costly tunnel or over an expensive bridge.

Some question has arisen on the above point, however, as, since the passage of the Inter-State Commerce Bill, one at least of the railroad companies between New York and Boston has been making efforts to charge more per mile for taking passengers and freight over an extremely costly portion of its road than the legal rate per mile over cheaper parts, thus making the mileage more on an expensive road than on a cheap road. As yet this question as to whether companies have a legal right to so charge for special or constructive mileage more than their actual mileage has not been decided.

The statement that either grades or curves act as the limit of the amount of work that can be done by one locomotive may be explained as follows: A locomotive can haul a certain number of loaded cars or a certain number of tons

PLATE XLVI.

Fig. 1.

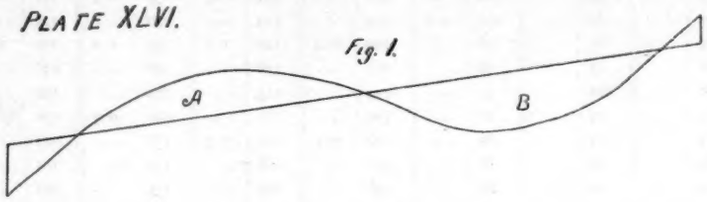
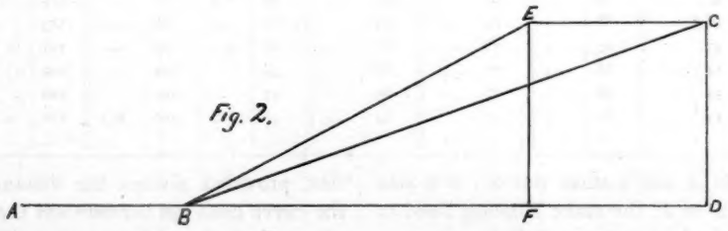


Fig. 2.



on a straight and level track. Wherever a curve is introduced this curve presents a certain amount of resistance to the passage of a train, and consequently a locomotive which is worked up to its full power on a curve hauls less than its full load on a straight line, where the road over which it runs is made up of curves and tangents; the amount of power wasted on a straight road being equal to the amount of resistance due to the curve, provided the curve was equal in length to the tangent. Also, on a grade which presents a certain amount of resistance a locomotive can haul a certain number of tons, and when worked to its full power on the grade, of course the load is much less than can be hauled on a level track. On all the level track over which the engine pulls the train there is this amount of extra power lost. In other words, the evil due to both grades and curves is not so much in the actual power necessary to haul a given load over a grade or over a curve as it is the amount of power wasted in hauling this load over the straight and level track which alternates with the grades and curves in the line.

There is comparatively slight difference in the cost of running a locomotive working up to its full limit of power and one working only at half or quarter of its full power. So, in plain language, the loss to the road is not what the locomotive *has* to do on a grade or a curve, but what it *has not* to do on a level, straight track.

CHAPTER XXIV.
VIRTUAL LENGTH.

Now, from the notes of the preliminary survey we have a profile of the actual line run on the ground, and when an accurate contour map has been made of the belt of country through which this line passes, we are able to make approximate profiles of any desired line. In this way we are able to run, on paper, as many lines between terminal points as are deemed necessary and to make an approximate profile of each line. It is thus easy to see the great advantage and economy of having a correct contour map of the country. In some exceptional cases it is necessary to actually run several lines on the ground, but whether this is the case or not makes no difference so far as the question which we are now considering is concerned.

We have on paper the alignment and profile of what appear to be the best lines for the future road between terminal points. These lines may differ one from another in several ways. They may differ as to actual length, as to the number of degrees of curvature, and as to their grades or the number of feet of actual rise and fall in each. As to the difference in length, we will first assume this to be so slight as not to increase the actual number of stations, but simply to a slight extent the expense of doing the work. We will then examine differences so great as to actually increase the number of trains required, with all the expenses pertaining thereto, to do the same amount of work. On all the lines which we are to consider the amount of future traffic is taken as being exactly the same. Of course, in some cases it is possible to run several lines between terminal points, some of which will give more future traffic than others. When this is the case it simply presents another element which must be carefully studied and considered in the comparison of the lines, but at present we will simply assume the amount of traffic equal for all lines. The relative advantages of these lines to be compared are so slight that we cannot, by observation, decide which line is the best, and it is necessary, therefore, to institute an exact mathematical comparison.

In order that there may be no misunderstanding, we will state the proposition again. We will take two lines between the same terminal points, the amount of future traffic over each to be exactly the same, and every difference to be so slight as simply to increase the expense of doing the work without necessitating additional trains, stations, or employés of any kind. These lines may differ:

1. As to their length.
2. As to the amount of curvature, and
3. As to their grades, or the actual amount of rise and fall.

In order to compare these two lines we must reduce them all to some common standard, and this standard is a straight, level line—that is, a line without grades or curves, which is an ideal railroad line, so far as operating expenses are concerned.

This reduction of a given line to an ideal line may be made in terms of:

1. The amount of motive power developed, or,
2. In terms of the cost of operation—in fact, in terms of any element that enters into the running of trains or the preservation of the road-bed and superstructure.

In Europe this comparison is usually made in terms of the motive power developed, but in this country in terms of the operating expenses, and these last, or operating expenses, are what will be used here. Thus the actual lines with curves and grades will be reduced to level, straight lines of such length that it will cost exactly the same to haul the same train from one end of them and return, as it would cost to haul it over the actual lines with the curves and grades, considering not only the cost *per se* of running the train, but all the expenses of repairs, renewals, etc., both to the rolling-stock, road-bed, and superstructures.

The length of this ideal equivalent, straight, level line is called the VIRTUAL LENGTH of the actual line, and when the lines to be compared are thus reduced to their virtual lengths a simple comparison of these respective virtual lengths will at once give the relative economy and advantage of each line in regard to operating expenses.

The resistance due to the movement of the train is as follows:

1. The resistance due to friction of every kind, such as the rolling of the wheels on the rails, the journals in the boxes, and the resistance of the air. All of these resistances must be overcome by means of the motive power in order to run a train on a level and straight road.

2. The resistance due to grades which, in addition to the resistances encountered on a level, straight line, present the resistance of gravity on an inclined plane, due to the fact that the whole train is lifted bodily the vertical height which is overcome by the grade.

3. The resistance due to curves, which resistance is due to the increased friction between the flanges of the wheels and the rails, caused by the rails continually changing the direction of the train from the straight line which it would naturally follow to a curved line, and to the slipping of the wheels on the rails.

We always have the resistance due to the movement of the train on a straight and level line, and what we wish to find is exactly how much this resistance is increased by each foot of rise and fall and by each degree of curvature, and finally how much the operating expenses are increased by this increase of resistance; also how much the operating expenses are increased by a slight additional increase

in the length. The resistance opposed to the motion of a train on a straight and level line has been found to be about 9.3 lbs. per ton of train hauled. This amount varies, to a certain extent, with the attending circumstances in each case, and the various elements which go to make it up are too complicated and numerous to admit of a discussion of them here. One of these elements, for example, is the resistance of the atmosphere. This will vary in each particular case, changing according to the direction and force of the wind and the speed of the train. The total resistance of the train hauled varies with the length and weight of the train, the resistance due to moving a short, empty train being much greater relatively than that of a long, fully loaded one. The resistance also varies directly as the square of the speed. This being the case, we can only take the average resistance for an average train at an average speed. Therefore, we will assume the speed of the train to be about 15 or 20 miles per hour, and the resistance to be overcome 9.3 lbs. per ton of train hauled. The resistance due to grades or the increase of motive power necessitated by the presence of grades is simply the amount of power required to lift the train vertically the number of feet rise of the grade.

It takes, as we have assumed, 9 lbs. per ton to haul a train from *A* to *B* (Plate XLVI, fig. 2), and to haul it from *B* to *C* would take 9 lbs. plus the amount of power necessary to lift one ton vertically from *C* to *D*. When the grade that is being considered is not the ruling grade of the road, the rate of grade has nothing to do with the increased amount of power required. Thus it would take exactly the same increase in the amount of power required to move a train from *B* to *C*, or from *B* to *E*, or from *B* to *F*.

(TO BE CONTINUED.)

NOTES ON STEAM HAMMERS.

By C. Chomienne, Engineer.

(Translated from the French under special arrangement with the Author.)

CHAPTER I.

HISTORY OF THE HAMMER.

Before beginning this study we shall give a brief historical account of the direct-acting power hammer, in order to show clearly to the reader the progress which has been made in the construction of this tool from the date of its first invention.

The invention of the direct-acting hammer dates from the year 1840, and was not only a considerable event in itself, but was also the point of departure of a new era in metallurgical industry, the construction of large steam-engines and of the material for railroads. Without this tool it would have been impossible to forge the heavy pieces used in the construction of large marine engines; to forge in one piece the wrought-iron wheels used on locomotives and cars; to make the armor-plates of iron and steel which protect our war-ships, or the steel guns, the dimensions of which are every day increased.

Struck by the fact that the heaviest forge hammers in use about 1840 were insufficient in size to forge or to weld the shafts and cranks which were required in the construction of steam-engines, several engineers in France and in England, at about the same time, conceived the idea of suspending a mass of wrought or of cast iron from the piston-rod of a vertical steam cylinder, this block of iron forming a hammer, which was to be raised by means of steam introduced under the piston, and was then to be allowed to fall back upon the piece to be forged, conveniently placed upon an anvil. It appeared to them that this arrangement would enable them to vary the weight of the hammer, and the height of its fall within limits much more extensive than the existing hammer permitted.

Among these engineers, two men of great ability, both driven by the same necessity—James Nasmyth, in England, and François Bourdon, in France—followed up this idea, each on his own account, without knowing what the other was thinking of. Both had in view the same object of forging the heavy pieces for marine engines of a power greater than any which had been built previously to that time.

Nasmyth made a simple sketch of his idea in his sketch book, while Bourdon, who was then Chief-Engineer of the Creusot Works, made a detailed drawing of his steam hammer, which he executed in 1840, and for which MM. Schneider Brothers, proprietors of the Creusot Works, took a patent in their name, September 30, 1841. This design was shown to all the engineers who visited Creusot, and especially to MM. Mimeret, Bertrand, and Paulin, all three of them naval engineers, who were then in charge of the construction of marine engines which were being built for the State.

The sketch of Nasmyth's steam hammer bears the date of November 24, 1839, and it was also in 1839 that Bourdon had the idea of a direct-acting steam-hammer, to which he gave the name of "Pilon," which the tool has retained to this day in France.

The sketch of Mr. Nasmyth was shown to Messrs. Humphries, Brunel, Guppy, and several other competent engineers, who approved the idea; but the marine engine for which the English engineer had specially conceived this idea, and fixed it on paper, was not built, and the invention remained on paper.

At this time, that is, in 1839, the idea of such a tool seemed so daring that the Schneiders hesitated for a long time before building one.

Toward the middle of 1840 MM. Eugene Schneider and Bourdon visited England in order to study and report on the best forge hammers there used, and it was during their visit to the Nasmyth Works that Mr. Gaskell, Mr. Nasmyth's associate—that gentleman being absent at that time—showed them the sketch of the hammer. This sketch being still incomplete in its details did not answer all of Bourdon's ideas, and he presented some objections, spoke of the hammer which he had designed in France, and drew with a pencil a sketch showing how, on his part, he had arranged the new machine.

After his return to France, M. Schneider, struck by the same idea which had presented itself at the same time to two men of distinguished merit, resolved immediately to put into execution the Bourdon plan of 1839. This hammer had been at work successfully for fifteen months when, in April, 1842, Mr. Nasmyth, on passing through Creusot, paid a visit to M. Bourdon, who asked him if he had put into practice his idea of the steam hammer. Nasmyth answered somewhat evasively, that he was studying out the machine and that he expected to build it very shortly. Bourdon showed him the design of the hammer, asking what he thought of the arrangements, and then invited him to walk into the shops and see it at work. When he saw it, Nasmyth stood still an instant, and then said to Bourdon: "I am delighted to see before my eyes what I have so long carried in my head."

It then appears that it was only after having seen the Bourdon hammer at work that Nasmyth returned to his sketch, and undertook the completion and execution of it, while the sketch shown to Bourdon by Gaskell did not at all change the plan which Bourdon had studied out before his visit to England. It must therefore be certainly admitted that the sight of the hammer at work at Creusot, and the confidence which Bourdon reposed in him by relating the difficulties encountered in working out the details of the machine, must certainly have fixed in Mr. Nasmyth's mind the idea which he had originally conceived.

The direct-acting hammer is thus really the invention of Bourdon; it is true that the English have tried to dispute his claim, but the facts abundantly prove the priority of the French engineer, while at the same time they do not really detract from the merit of his contemporary, James Nasmyth.

The first direct-acting hammer built at Creusot had a weight of 2,500 kilogrammes and a fall of two meters.

Since then these shops have built a great number of steam hammers applied to special work, and varying from time to time in form and dimensions.

La Compagnie des Fonderies et Forges de l'Horme has also made a specialty of the construction of these machines; it has furnished many of the establishments of the Loire with magnificent tools, which in skillful hands have produced some very remarkable forgings, and which bear witness to the enterprise of the makers and the excellence of their design.

In France the single-acting hammer is most generally used for forgings. In England the double-acting steam hammer has been employed, even for very large hammers, by many builders, such as Nasmyth, Wilson, and Thwaites. The last-named built for the Elswick Works of Sir William Armstrong a double-acting hammer of 35 tons; and a hammer, also double-acting, of 50 tons, for the Oboukoff Steel Works, near St. Petersburg.

In 1860 there was built at Creusot, for the forges of the Navy at Guérigny, a 20-ton* hammer.

In 1873, at the Vienna Exposition, there was shown a design for a 50-ton hammer built for the gun-factory at Perm, in Russia.

In 1878, at the Paris Exposition, the Creusot Works showed a model in wood of an 80-ton hammer, which was then under construction in the shops. The design of this hammer was subsequently modified, and its power increased from 80 to 100 tons.

In 1878 the Naval Steel Works, at St. Chamond, France, built an 80-ton hammer, intended, like that at Creusot, to forge heavy guns and armor-plates.

In 1885 the Société Cockerill, at Seraing, Belgium, built a 100-ton hammer intended for the Terni Steel Works in Italy.

In 1886, Marrel Brothers, at Rive de Gier (Loire), France, built two hammers, one of 50 and one of 100 tons.

The Bethlehem Iron Works, at Bethlehem, Pa., in the United States, are now building a 125-ton hammer intended to forge heavy shafts for marine engines and guns, armor-plates, and other war material.

CHAPTER II.

CLASSIFICATION AND PARTS OF THE HAMMER.

This study of steam hammers will include:

I. Single-acting hammers; that is to say, those in which the steam acts only upon one side of the piston, to raise the hammer; these are used chiefly to make the heaviest forgings, such as armor-plates, guns, shafts, crank-shafts, and axles for steam-engines or locomotives, die-work, and, in general, all mechanical forgings.

II. Double-acting hammers, whether automatic or not, in which the steam acts on both sides of the piston: 1. On the lower side to raise the hammer; 2. On the upper side to add its power or its force to that due to gravity alone.

III. Power hammers operated by compressed air, by springs, and finally those operated by belts.

I. Considering first the single-acting steam hammer, we now come to the study in detail of each of the parts composing a direct-acting hammer, which may be placed in the following order:

1. The foundations.
2. The bed-plates and sockets.
3. The legs or uprights; the frame.
4. The upper bed-plate or table.
5. The apparatus for distribution of steam.
6. The cylinders and arrangements for controlling the hammer action.
7. The pistons and piston-rods.
8. The hammer.
9. The holding dogs or safety-catches.

CHAPTER III.

THE FOUNDATIONS.

For small hammers in which the ratio between the weight of the working parts and that of the bed-plate is 1 : 10, and especially when the base has a wide surface, there is often used the method shown in fig. 1.

In the first place a bed of beton varying from 0.500 to 0.800 meter in thickness is put down; upon this mass there is constructed a box or trench of masonry, the interior dimensions of which are the same as those of the base of the bed-plate, and whose height varies from 1.000 to 1.500 meters. This gap is filled with clean river sand, slightly damp, which is rammed down hard in layers of from 0.100 to 0.150 meter thick at the outside. This plan has the advantage of not costing very much and of making it easy to reset the hammer in case it should get out of line; for that purpose it is sufficient to raise the bed-plate a little and to work in sufficient sand to restore it to a horizontal position. This system, however, should only be employed where the hammer is some distance from the furnace, because otherwise, under the action of the heat, the sand will dry more on the side toward the furnace and will sink down unevenly and thus occasion frequent changes of level.

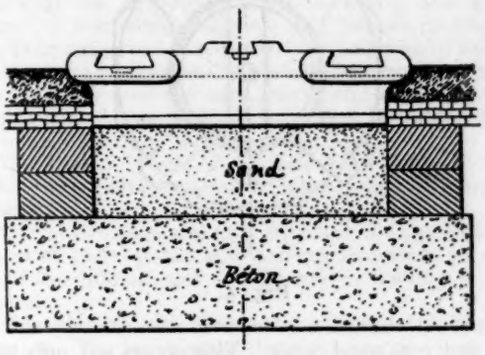


Fig. 1.

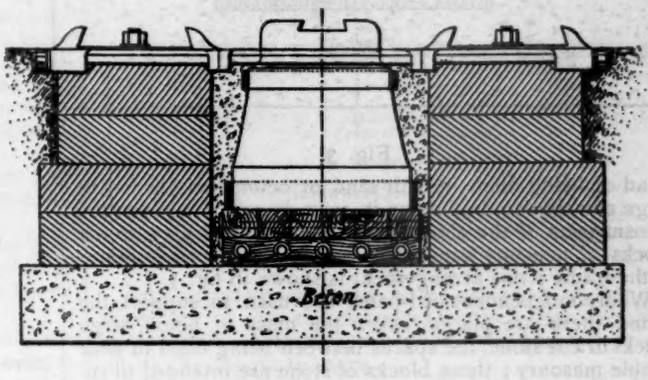


Fig. 2.

For the foundations of a larger hammer more care must be taken. It is necessary to study first with care the nature of the soil on which it is to be placed, for it is this which will determine, to some extent, the system of foundations which should be adopted; this done, it only remains to make judicious choice of the materials to be employed, and to watch with care the execution of the work.

A pit for the bed of beton should be dug out until the rock or a solid foundation is reached, and the bottom of this pit should be perfectly level; in case the subsoil is light and does not present sufficient firmness, it would be necessary to drive piles.

The hole dug for the foundation is filled with a bed of beton, mortar, and hydraulic cement, and on this bed, the thickness of which varies from 0.800 to 2.000 meters, according to the depth of the rock below the surface, there is placed a bed of masonry of large cut stones, upon which are again placed two horizontal layers of oak timbers, firmly bolted together and with the joints crossed, as shown in fig. 2.

In some very large hammers these horizontal layers are replaced by a foundation formed of oak timbers from 0.250 to 0.350 meter square, carefully framed together,

* The ton used here is the metric ton of 1,000 kilos, or 2,204 lbs.

and joined by wrought-iron wedges, as shown in fig. 6; the height of this foundation varies from 0.600 to 1.200 meters. In some cases, and to avoid the use of the wedges, this timber bed is surrounded by a wall of masonry, as shown in fig. 3.

This timber bed is intended to absorb, in part, by its elasticity the vibrations due to the blow of the hammer upon the anvil, which are transmitted to considerable distances; these distances varying with the nature of the soil.

At Creusot, in the foundations of the 100-ton hammer, the gap between the bed-plate and the masonry walls, in-

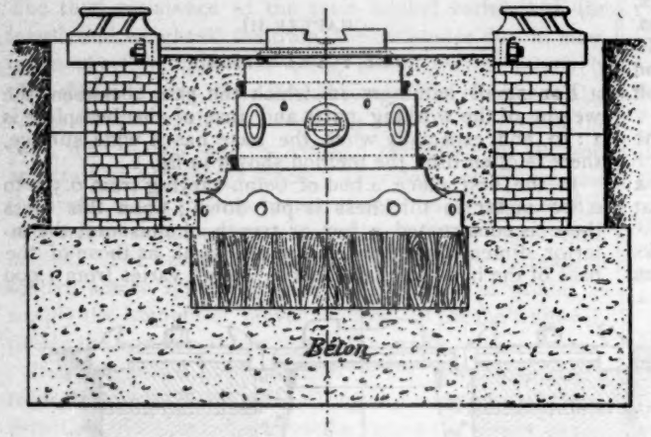


Fig. 3.

stead of being filled in with sand or beton was filled with large oak timbers laid down in rows, in order to lessen the transmission of the shocks from the main bed-plate to the blocks of masonry supporting the independent bed-plates of the frame; this arrangement is shown in fig. 5.

Where independent bed-pates are used to support the frame there are placed below the mass of beton large blocks of cut stone, the spaces between being filled in with rubble masonry; these blocks of stone are intended to receive the bed-plates for the frame. These bed-plates are fixed, as is also the frame, to the masonry, by heavy keyed bolts with wide heads and washers below, so that the bolts can be tightened from above; such bolts are shown in figs. 5 and 6.

CHAPTER IV.

THE BED-PLATES.

We distinguish two classes of these bed-plates or foundation-plates.

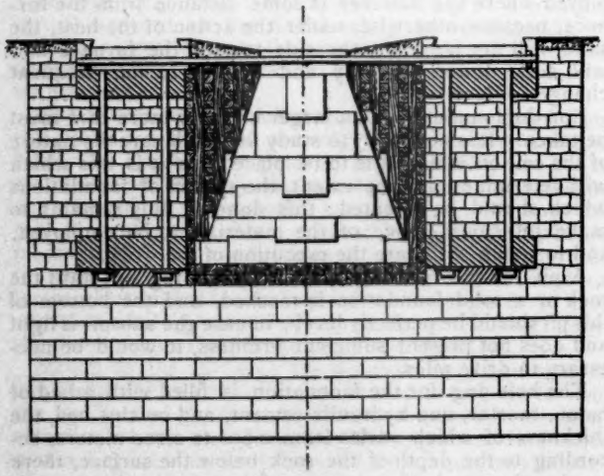


Fig. 5.

1. Bed-plates receiving the uprights directly, as shown in fig. 1.

2. Sockets independent or separate from the main bed-plate, as shown in figs. 2, 3, 4, 5, and 6.

The first type can be used for hammers whose power does not exceed 10 tons. Marrel Brothers, of Rive de Gier, have, however, used this type for all their hammers up to 50 tons.

The second type is usually employed for hammers of 10 tons or over.

The objection to hammers whose uprights rest directly on the bed-plate is that, in spite of the great dimensions and weight of the upright, and whatever method of fastening to the bed-plate may be adopted, they will always after a time work loose, under the influence of repeated heavy

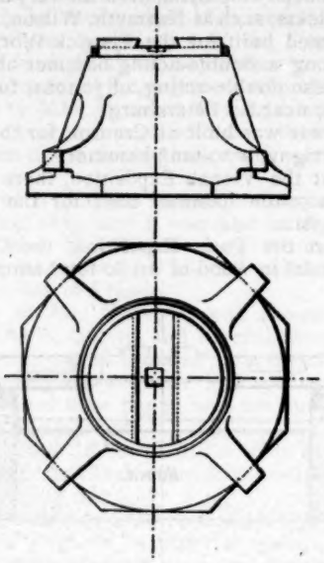


Fig. 4.

blows and continued work. This occurs not only below, but also above, at the junction with the cylinder bed.

Where the independent or separate socket is used, these inconveniences disappear, and a more complete stability is secured. This system also permits a reduction of the section of the uprights, as the reactions produced by the blows of the hammer are very much diminished.

The form of the bed-plates of the first type varies according to the arrangement of the uprights and their size; in all cases the object should be to give the base the greatest size possible, in order to increase the stability.

The form of the sockets of the second type varies ac-

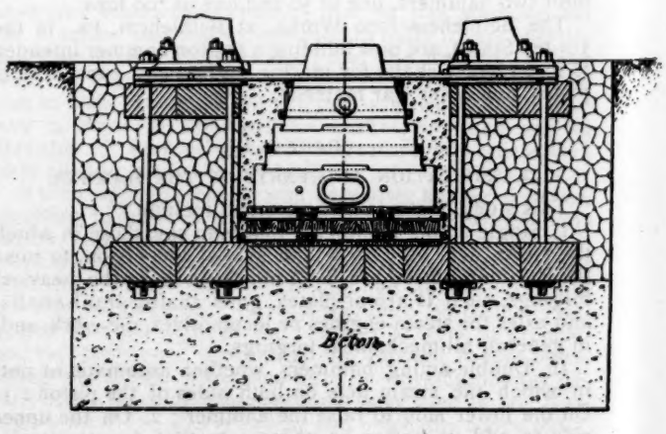


Fig. 6.

cording to the designers; they are given generally the form of a truncated cone or pyramid, with a square or rectangular base; this form is adopted in order to avoid any rotary movement, and to keep the dovetails or wedges

exactly in the axis of the hammer. This is an indispensable condition to make the hammer and anvil correspond properly, that is, to bring the striking surfaces directly opposite each other.

These sockets or foot-pieces may be in one or in several pieces, according to the conditions in which they are placed. If their transportation presents serious difficulties, or if it is desirable to avoid the adjustment of the parts, the bed-plate may be cast in place, and in a single piece. For this purpose cupolas are placed at the site chosen for the hammer, the bed-plate is then moulded and finally cast. The mould is always arranged in such a way as to have the bed-plate reversed, that is, the base uppermost, and two trunnions or journals sufficiently strong to support the plate are placed at a proper height.

As soon as the casting is sufficiently cooled—the time varying according to the size and weight—the sand, etc., are cleared away from the casting, care being taken that the trunnions are supported properly. The bed-plate is then allowed to turn by the action of its own weight—the trunnions having been placed a little above the center of gravity—and all that remains to be done is to lower the plate into its place, after having prepared or dressed off the upper face intended to receive the anvil-block.

It may be noted that a large bed-plate should be left at least one or two months in the sand before stripping it, and that the stripping should be slowly and gradually done. It sometimes happens that bed-plates which have not been subjected to blows or shocks break in two. This is due to the fact that the casting has been stripped and the sand removed too soon, the center not being yet sufficiently cooled; the molecules are then in a state of tension which is broken by the first blow.

The Bietrix Works, at St. Etienne, France, in this way cast two bed-plates, one of which weighed 65 tons, and the other 95 tons.

Marrel Brothers also cast in place the parts of the bed-plates of their 50-ton and 100-ton hammers, in order to avoid the difficult and costly work of moving such heavy pieces.

This plan is also frequently adopted by English engineers. The bed-plate of the great hammer built at Perm (Russia), in 1873, which weighed in all 623 tons, was cast in place, and has now been in use 15 years without giving any trouble.

Quite recently, at the Terni Steel Works in Italy, a bed-plate weighing 1,000 tons was cast in place; the operation succeeded so well that there is every reason to expect that this plate—the largest piece ever cast—is perfectly sound and able to resist all the blows which it is likely to receive.

When the bed-plates are in several parts, each horizontal seat, whose weight is not over 80 or 100 tons, should be preferably in one piece, and each of these seats or plates should be finished on the edges with great care, in order to secure perfect contact of the parts and to make the plates exactly parallel. All these plates are then brought together by means of a series of hoops or bands put on hot, and by clamps which make all displacement impossible, and make the whole a compact block which cannot get out of shape.

All bed-plates should have on the outer edge and at a certain height (as shown in fig. 3) a series of holes, in which can be placed round bars of iron or steel to serve as points of attachment for lifting-jacks or cranes, when it is necessary to move them.

In some cases lugs or arms are made on the casting, which serve the same purpose. An example of this is shown in fig. 4. The first plan is better, however, both because it is safer, and because the plain casting is more easily moulded.

In general, and where there is a good foundation, the ratio between the weight of the active part of the hammer and the weight of the bed-plate should never, in a single-acting hammer, be less than 1 : 6, and the base should be given the largest surface possible, the height being also reduced; under these conditions a bed-plate will act well and will not be apt to get out of level.

This may be verified by the formula:

$$Q = \frac{T}{m + 2}.$$

In this formula Q represents the quantity of work lost during the blow; T the falling force or force of gravity developed during the blow; m is the ratio between the weight of the bed-plate and that of the active part of the hammer.

An inspection of this formula will show that Q will decrease as m increases. Thus, if we assume $m = 6$, we will have:

$$Q = \frac{T}{m + 2} = \frac{T}{8} = 0.125\ T.$$

If we assume again $m = 10$, we have:

$$Q = \frac{T}{m + 2} = \frac{T}{12} = 0.0833\ T.$$

In the case of foundations on light or shifting subsoil, the ratio 1 : m should never be less than 1 : 10, and the base of the bed-plate should have as large a surface as possible.

As noted above, however, where a hammer of any size is placed where the subsoil is light or of a shifting or uncertain nature, it will generally be necessary to drive piles for the foundation to rest on.

(TO BE CONTINUED.)

NOTES ON THE SEWERAGE OF CITIES.

(Translated from paper of M. Daniel E. Mayer, Engineer, in the *Annales des Ponts et Chaussées.*)

(*Continued from page* 209.)

III.—VOLUME OF WATER TO BE DISCHARGED BY SEWERS.

THE principle which we have laid down above, of determining of the size of sewers by their duty, requires us to establish as exactly as possible the quantity of water which they ought to carry.

Waters which sewers must discharge may be divided into two classes.

1. Waste or polluted waters, including the product of water-closets; waters of public service, and water from industrial establishments; that is what we call ordinary duty.

2. Rain water.

Sewers can also, in some cases, receive a third class of water, that of land drainage. In general, however, the street sewer should not be considered as a means of drainage. For stability and economy they should be built as much as possible above the subterranean water-basins; and besides there should be no communication between them, in order to avoid pollution of these subterranean systems. Drainage of low grounds, in cases where it is necessary, should be done by distinct channels, drains built for the purpose. It may, however, happen that a main or collecting sewer may be sufficiently low to receive the flow of such drains. This, although an interesting matter, is, from our point of view, only accessory to the general question of sewers. The danger to health of which we have spoken above, resulting from the fluctuations of the subterranean waters, can be usually avoided if the germs of infection are completely carried off, instead of being allowed to soak into the soil and mix with the water contained in it. As to the lowering and regulation of the subterranean streams, it is more often a matter of special interest to certain property owners than a public necessity. If the other requirements of the system make it necessary to build sewers of such a kind that they can receive the drainage of low spots of ground, so much the better; but we should guard carefully against increasing the expense which falls upon the entire community, in order to drain the cellars of certain buildings which have been placed too low. For these reasons it is not necessary to consider the drainage question to any extent.

The total volume of the waste waters of the public service and of manufactories can usually be easily deter-

mined, especially in those cities where there is a public distribution of water.

In Paris, the public service (the sprinkling of streets; the washing-out of the gutters; the waste of the public fountains, etc.) is of very large volume, corresponding to something over 100 liters of water per inhabitant per day. It must be noted, however, that the washing out of the gutters, which absorbs the larger part of this consumption, should be considered as an extra service, applicable only to Paris, and which will have little or no interest in a city where, by a complete system of sewerage with which all the houses are connected, the refuse water is carried off below ground, and is not allowed to run into the gutters. The public service, reduced to sprinkling of the streets and the waste of public fountains, should not represent in a city more than 10 or 15 per cent. of the amount of the private service.

It may be noted that the street gutters are not washed out either in London, Berlin, or Vienna.

The daily consumption for private use is fully satisfied, as a rule, with less than 100 liters per inhabitant per day.*

It may be accepted, then, as a rule, that in a city where there is not a large consumption of water for manufacturing purposes, the sewers will not have to carry more than 150 liters per inhabitant per day. In Berlin, in Vienna, and even in Paris (if in this last-named city the public service is deducted), the real quantity is considerably below these figures.

If, then, we designate by S the number of hectares served by a sewer, and by N the number of inhabitants per hectare, the ordinary duty of the sewer in cubic meters per 24 hours will be generally well expressed by the formula

$$q = 0.150\ S\,N.$$

If this whole duty is confined to 12 hours of the day, the following formula will give an approximate value of the average duty per second:

$$Q = 0.00000347\ S\,N.$$

It may be noted here that the average number of inhabitants per hectare is in Paris, 300, in Berlin, 200, in Vienna, 135, while in several smaller French cities it varies from 133 to 50.

The existence of large manufacturing establishments consuming much water may render this estimate much too low; a factory having steam-boilers of 500 H. P. will, with condensation, take alone a quantity of water greater than the entire consumption of a city of 20,000 people. It is generally the case, however, that these large establishments are found in valleys or in the lower parts of towns, and the waste water when comparatively pure, like water of condensation, can be conducted directly into the river.

In any case the ordinary duty can be easily calculated, and although it will vary from one day to another, and from one moment to another of the day, it will nevertheless present in total a certain regular character. All the water discharged does not, it is true, reach the sewers; a portion is lost from various causes, but it would be much more difficult than useful to take account of these losses in our estimates.

It is not the same with rain water.

If we average through the year the total rainfall received in the basin by the sewers, we will easily obtain in this climate a figure lower than that which we have indicated, for the ordinary duty of the sewers. But in reality this average is not of practical interest. It would be an advantage toward working out the problem if we could divide the total annual rainfall by the actual time during which rain fell. At Paris, for example, where the average total annual rainfall is about 0.006 meters, observation has shown that the actual time during which rain fell averages 0.052 of the total time; from this we may calculate the average amount of rain per hectare per second as follows in cubic meters:

$$\frac{6.000}{365 \times 86{,}400 \times 0.052} = 0.00366.$$

Of this, however, only a part reaches the sewers, on account of loss by infiltration and by evaporation. In larger cities, where the loss from these causes is relatively small, because the greater part of the surface is either built on or paved, it is probable that two-thirds of the water which falls reaches the sewer, and if we accept this as the basis of calculation, we find that the duty of a sewer in an average rain would be double its ordinary service. It must be remembered that we are here speaking of an average rain. The duty per second due to this rain will be generally less than the formula above indicates, because it is necessary to take account of the time which rain occupies in reaching the sewer. It is seldom that we are called upon to carry off more than one-sixth of the quantity of rain which falls during a given time on the area served.

In smaller cities it is probable that a different report would be made, but it must be remarked that the terms upon which the report depends would vary in the same direction. Where the density of population is less, the proportion of gardens, vacant and cultivated land is greater, and it would thence result that a much larger proportion of rain would be lost before reaching the sewers, while on the other hand the ordinary duty per hectare also diminishes in proportion to the density of the population. It is therefore extremely probable that the proportion given for Paris can approximately apply to other cities.

However this may be, this calculation will not give us the maximum capacity which the sewers should have to carry off rain water. There are violent rains and showers in which in a few minutes there may be 40 or 50 times as much water fall as we have calculated above. Different observers have estimated the greatest known rainfall, in this climate, at from 0.125 to 0.160 cubic meters per hectare per second.

It would, however, be entirely unnecessary to insist that the sewers should have sufficient capacity to carry off so great a rainfall as this. In the first place, there are the losses above referred to, by infiltration and by evaporation. Further, the total capacity and extent of the system of sewers is seldom called upon to receive the volume of water falling in these exceptional rains, which if very violent are generally very short. The sewers will have a certain time to fill and discharge themselves, and the chances are that the intensity of the shower will have passed before any serious obstruction will take place.

It is to be desired that rain water should be promptly carried off, but it is admissible to take for the discharge a somewhat longer time than the duration of the rain, and the resulting inconvenience will be much less serious than that resulting if we give the system too great a capacity, merely to provide for a few exceptional cases.

Taking into consideration these different points of the question, Belgrand estimated that at Paris the sewers ought to provide for a volume of rain water equal to one-third of the maximum fall—that is, 0.04167 cubic meters per hectare per second. The figure adopted for Berlin was only one-half of this.

Without entering into a profound discussion of this problem, which is really a very complicated one, and which has caused the flow of oceans of ink, we should advise the adoption, in a climate like that of Paris, of the figure of Belgrand given above, deducting, however, in the calculation of the amount of surface, gardens and other cultivated or unoccupied land.

Thus calculated, the maximum duty of a sewer for rain water is about 30 times as great as the ordinary discharge.

This result will without doubt differ in different cities, but it will serve for a general approximation.

Some English engineers have proposed to adopt for certain cities two separate systems, one for rain water and one for the ordinary discharge, holding that the same system cannot be made to serve two discharges, the conditions of which are so different. We do not believe, however, that it would be well for cities to adopt two separate systems; partly because two systems would be very much more costly than one, and partly because the rain water will sometimes serve a useful purpose in assisting the discharge of waste water and washing out the sewers. There is still another reason opposed to this plan, and that is, that in times of only average rainfall, or in dry seasons, the water which falls is heavily charged with organic matters, taken up in passing through the air, or in running

* M. Mayer's estimate (22 gallons) per inhabitant per day is lower than would be generally accepted in this country.—EDITOR.

through the gutters, and that considerations of public health would not allow the discharge of such waters into rivers. In reality they would be almost as dangerous and would pollute the natural water almost as much as the ordinary discharge of sewers.

It may be the case, however, in small towns, where the surface of the ground is such as to give sufficient slope to permit rain water to flow freely, and where an occasional overflow at a street-crossing would not be a serious evil, it might be possible for reasons of economy to suppress entirely the discharge of rain water, and thus to reduce very much the necessary dimensions of the sewers. It is also possible to imagine some arrangement by which in wet weather a portion of the rain water may drain into the sewers at certain points, and thus be used to flush or clean them out.

To return to the more general case of a system which is to receive at the same time both discharges, we may remark here that if the highest figures given above be accepted, the dimensions of sewers required to receive the maximum volume of rain water would tend to become enormous, where they have to serve any large extent of surface. In Paris, for example, where the total surface served is about 8,000 hectares, the main or collecting sewers should be able to discharge 320 cubic meters per second; that is, seven or eight times more than the flow of the Seine at low water.

The construction of such gigantic works would be impossible, but fortunately their size can be very much reduced.

We must, in fact, consider that when the intensity of a storm exceeds the average rainfall, the foul waters are mixed or diluted in an enormous quantity of pure water, and that at the same time the volume of water in the river is very much larger than usual; we thus arrive at the conclusion that in very heavy rains it is permissible to discharge the surplus from the sewers into the river. This is what is done in Paris, Berlin, and Vienna, and in many other important cities.

We should have, therefore, at certain points conveniently chosen, and especially in the main sewers, arrangements by which the water can be diverted into overflow passages connecting directly with the river. Where a new and properly arranged system is introduced, the old sewers can sometimes be utilized for these overflows.

Thanks to these considerations, the data which we have indicated above, for calculating the maximum amount of rain water to be discharged, must be accepted only in that portion of the system which is highest and most distant from the main discharge. In the lower portions of a town furnished with overflows the capacity of the works above the level of the main sewer may be determined by the ordinary discharge, increased by the amount of an average rain, which, as we have already shown, will give a total of about three times that of the ordinary discharge.

It is hardly necessary here to recall the fact that in estimating a system of this kind, we must always consider the future, in which, by the increase of population or by construction of new buildings or factories, the volume of water to be handled in the sewers may be considerably increased. The engineer must study the future, but he must, on the other hand, remember that the money saved by present economy may constitute a fund on which his successors may be able to draw to better advantage, because with fuller knowledge of what is needed.

(TO BE CONTINUED.)

The British War-Ship "Nile."

A NEW war-ship named the *Nile* was launched at the Pembroke Dock-yard on March 27. The following description of the vessel is from the London *Times*:

Before proceeding to describe what kind of ship the country will in course of time obtain in the *Nile* for the million or so of money which she will eventually cost, it will be best, in order to provide against mistakes, to say what she is not. Though she divides with the *Trafalgar* the honor of being the heaviest armor-clad in the service, she is exceeded in length by the *Achilles* and in beam by the *Inflexible*. She is not the quickest armor-clad, neither does she carry the largest ordnance afloat. Though the number, nature, and relative positions of her heavy guns are the same as in the *Admiral*, she differs from that class in carrying them in rotating turrets instead of in fixed barbettes. But while the turret principle has thus been re-established, the *Nile* varies from the *Victoria*—the latest embodiment of the system—in having double the number of turrets, and from the *Inflexible* and her successors, of the *Edinburgh* and *Ajax* classes, in the abandonment of the *en échelon* arrangement, as they are built forward and aft on the middle line of the ship, whereby direct fire ahead and astern is reduced by one-half. The *Nile* may be said to resemble the *Dreadnought*, upon which she was evidently modeled; but she has, among other advantages over her prototype, the important one of possessing a powerful auxiliary broadside battery high up between the turrets. The *Nile* has greater length, thickness, and depth of water-belt than the *Admiral* class, and though she is not like the early armor-clads, protected throughout her length by vertical armor, her invulnerability against the penetration of the heaviest guns afloat is immensely greater. Her engines will be of exactly the same horse-power as those of the *Victoria*, but notwithstanding the fact that she exceeds the Tyne-built ship in displacement by considerably over a thousand tons, yet in consequence of her superior lines and length she is expected to realize the same speed.

In short, it will be perceived that, although it has been declared impossible to design a perfect ship combining in herself the several excellencies of different types, it has been the evident desire of the designers of the *Nile* to combine as many good points in her as possible by a series of compromises. The *Nile* will possess great speed and offensive powers combined with efficient protection for all vital parts.

In none of these respects will she be likely to become antiquated in her armament and dangerous as regards her defense soon after being launched, provided only that the paramount factors of stability and speed could be kept in view. An ordinary cylindrical boiler would probably furnish the best design for a ship of war, since, besides securing a *maximum* degree of buoyancy, its contours would cause shot to deflect wherever it was struck. In the *Nile* curves of beauty, because they also happen to be of practical utility, have certainly not been lost sight of. Glanced at in midship section, her sides taper gracefully downward; while, if examined in plan, she presents the appearance of an elongated ellipse, having ogival ends like the head of a Palliser projectile. Forward her armored deck curves down from the lower citadel to the ram, while at the rear it is bent in the same way to support the stern post. The turrets are, of course, circular, but, for the purposes of protection against raking, the bases are inclosed within an upper citadel having rounded athwart bulkheads. The turrets themselves are surmounted by turtle covers, while the intervening box battery is octagonal in shape and consequently is as near an approach to a circle as was practicable. In length the *Nile* measures 345 ft. between perpendiculars and 73 ft. in beam. Her load draft will be 27 ft. forward and 28 ft. aft. When fully equipped for sea her displacement is 12,000 tons and her engines are contracted to develop the same number of horses under forced draft. The hull is built wholly of steel, the flat plates having an outer thickness of $\frac{3}{4}$ in. and an inner thickness of $\frac{5}{8}$ in., while the bottom plates are $\frac{9}{16}$ in.

These details, however, will afford only an indifferent idea of the structural strength, because the portions of the hull carrying weight and exposed to strains and blows are specially thickened and strengthened, more particularly in wake of the turrets and vertical armor. Thus it is officially stated that the side of the hull behind the heavy plating consists of two thicknesses of skin, the outer of 60 lbs. and the inner of 30 lbs. a square foot, riveted to plate and angle frames 2 ft. deep and 2 ft. apart. Inside of these, again, frame plating of 20 lbs. a square foot is worked, while the belt and citadel armor bolts are hove up between them on the inner end of a cast-steel sleeve 12 in. long. Within these frames and behind the belt armor is a second

system of lightened plate frames 3 ft. deep, spaced 4 ft. apart, upon the inside of which the outer bulkhead of the coal bunkers is riveted. Besides the solidity of the structural arrangements, the under-water portions are safeguarded by a unique subdivision double bottom, which is 3½ ft. in height and contain 40 water-tight compartments. There are also 13 before the double bottom and 18 abaft and 49 in the hold, including eight divisions in the coal bunkers, making altogether a total of 120 water-tight compartments below the protective deck. In addition to the above, however, must be added 14 similar compartments on the protective deck itself in wake of the water-line, and as these would be filled with stores, it is contended that they would give considerable buoyancy to the relatively limited unarmored ends of the ship when riddled. As a matter of fact, it is asserted that, should the unprotected forward end be entirely filled with water, the resulting sinkage would only amount to 3½ in. as compared with the 15 in. of additional sinkage of the *Admiral* class in similar circumstances. But should these various compartments be flooded, it is important to notice that exceptional means have been take to free them. This may be done either by hand or steam-power, or by both in combination, Downton's pumps being used for hand and the circulating pumps as well as the bilge-pump donkey-engines for steam-power. Each of the two main circulating pumps will be powerful enough to discharge 1,000 tons of water from the bilge in every hour in case of leak, while the two pumping engines and the couple of auxiliary engines can also be called into requisition for the same purpose.

When it is stated that the *Camperdown* would carry four 67-ton guns into action upon a displacement of 10,000 tons, and that the *Nile* would do no more with a displacement of 12,000 tons, it will be readily surmised that the latter must possess commensurate advantages in the way of speed, armored stability, and protection. Her great superiority as regards speed is universally acknowledged. Her total weight of armor, exclusive of glacis plates and protective decks (which may be roughly said to represent an additional 1,000 tons), is not less than 4,230 tons. The disposition of this enormous mass of compound armor is the distinctive feature of the hull. In the first place, the *Nile* is fitted with a belt thicker, longer, and extending both higher and lower than that of the *Admiral's*. It has a length of 230 ft. and a breadth of 8 ft. 6 in., and forms, with the boundary bulkheads, the lower citadel. The line is thus protected for 5 ft. 6 in. below and 3 ft. above the water. The plating varies in thickness from 20 in. to 14 in., tapering at the lower edge from 8 in. to 6 in., while the bulkheads are armored with 16-in. and 14-in. plating forward and aft, respectively, tapering downward to 7 in. It will thus be seen that each of the ends is denuded of vertical armor for the space of 58 ft. They are, however, protected by a 3-in. sloping steel deck in continuation of the belt. Above the lower or belt citadel is the citadel proper, 141 ft. long at the sides of the ship, but having an extreme length from the centers of the curved bulkheads of 193 ft. The plating varies from 18 in. to 16 in., while the thickness of the bulkheads which protect the bases of the turrets from raking has been perilously reduced to 8-in. The main-deck between the ends of the citadel and the end of the armored belt is covered with two thicknesses of steel plating, similar deck-arming forming the upper deck over the citadel. These figures will afford an idea of the defensive capacity of the ship, but in reality, in consequence of the peculiar arrangement of the framework and backing, the protecting barricades are of much greater solidity.

It also remains to be stated that, owing to the great length of the main citadel, it has been deemed expedient to subdivide it into three compartments by means of thin steel bulkheads, as a defense against splinters. The turrets are built at each end of the citadel. Within the limits of the armored belt, and circumferentially to the parabolas of the boundary bulkheads, they are armored to the thickness of 18 in., and will each mount a brace of 67-ton breechloaders. Both guns and turrets will be worked by hydraulic power. Superimposed upon the citadel is a box-battery pierced for six of the new 36 broadside quick-firing guns. In this respect the *Nile* differs from the *Trafalgar*, which is to carry eight 5-in. breechloaders. The ship will also have 18 machine guns and eight tubes for discharging torpedoes. As the side of the battery is only built of 1-in. plating, the guns' crews will be exposed to the fire of the smallest guns. The central portion of the *Nile* is a three-story arrangement, and as the turrets are not less than 120 ft. apart, it is, perhaps, to be regretted that some portion of the intervening armored side, which rises to the height of 11 ft. above the water, was not made available for a few thoroughly protected guns. In the *Nile*, as in the *Trafalgar*, the magazine and shell rooms are located in the lower part of a water-tight tunnel, which passes between the two sets of engines and boilers, and affords a means of communication between the ends of the ship.

The *Nile* will be propelled by two sets of triple-expansion vertical engines by Messrs. Maudslay & Co., which, with an indicated horse-power of 12,000, are expected to drive the ship at the rate of 16½ knots. The radius of steaming distance is officially stated to be 1,050 nautical miles at full speed and 5,500 at 10 knots. But all calculations of this sort are vitiated by the fact that the coal stores are not exclusively used for propelling purposes. The ship's galleys and fires will consume nearly a ton a day, while the fuel used in condensing amounts to about five tons a day. The *Nile* will also be original in the disposition of her funnels, since instead of having one behind the other, as has hitherto been universally the case, they will be abreast.

It only remains to be added that the ship will be fought from the pilot-tower on the spar-deck and from two conning-towers at the side, and that her steering will be controlled from five stations by steam-power and also by hand gear from below the protected deck. As the ship is not to be docked at Pembroke, her propellers were fixed in position before launching, two blades being secured on each shaft.

The *Nile* was built by Mr. Millard, Assistant Constructor, under the direction and superintendence of Mr. George Malpas, Constructor, and Mr. J. C. Froyne, Chief Constructor, from the designs of Messrs. Barnes and Morgan, of the Admiralty Constructive Department.

Torpedo-Boat for the Chinese Navy.

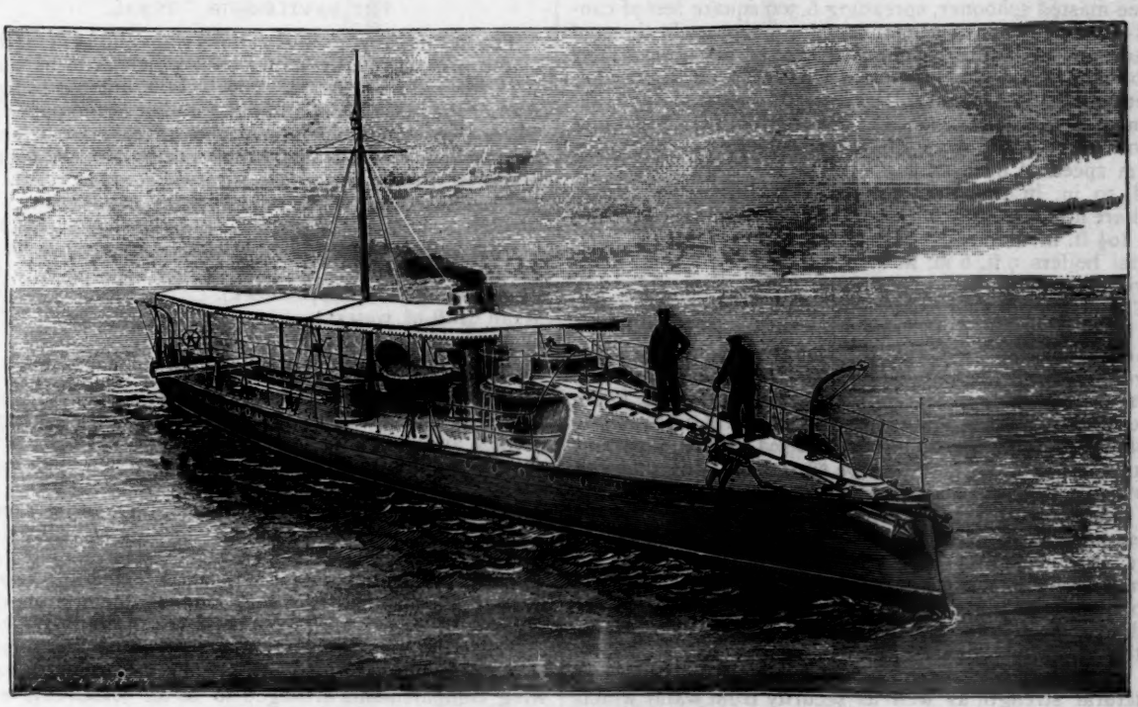
(From the London *Engineer*.)

THE torpedo-boat illustrated herewith represents probably the most useful type and size of such craft suitable for coast defense which has been hitherto constructed, it being capable of safely withstanding any weather and carrying a powerful armament. Smaller dimensions would not secure the needful seaworthiness and accommodation to make it suitable for remaining at sea for a lengthened period, and larger dimensions would unnecessarily augment the cost and increase the area exposed to an enemy's fire. This vessel was built by Messrs. Yarrow & Co., for Messrs. Birch & Co., in accordance with a contract between the latter firm and the Chinese Government. The opinion of many competent naval authorities at the present time seems to be that the limit in size for torpedo-boats properly so called, is that of the vessel we illustrate, and in support of this it may be mentioned that all the 50 torpedo-boats lately built for the British Government were of the same dimensions, although in speed very far inferior, excepting only No. 79, which was the first of this type constructed.

Recent advices have been received that this little vessel has most successfully made the voyage out to China with the rest of the fleet, notwithstanding that she encountered, at times, the very worst possible weather. We must congratulate the builders on having scored another success by combining in one vessel so great a speed with ample strength to withstand the strains to which she was subjected. Notwithstanding the high speed obtained, she is a comparatively full-lined boat, and can consequently carry a proportionately large supply of coal, stores, and armament, and possesses the most necessary quality of stability in a high degree. She is 128 ft. long by 13 ft.

beam, and her displacement on the official trial was a trifle over 70 tons. She is divided by water-tight bulkheads into 10 compartments; each compartment, except those at the extreme ends, has its own hand-pump and a steam ejector varying in power of delivery from 40 to 80 tons of water per hour. There is one large boiler, of the locomotive type, with a copper fire-box and brass tubes, constructed in accordance with the builder's most recent practice, and this is protected by coal bunkers on either side and also at the end.

The engines are on the triple-expansion principle, with three cranks and link motions, the air and feed-pumps being worked by the main engines in such a manner as to make them very accessible for examination. There is a large surface condenser, and provision is made for very perfect condensation by securing an exceptionally large amount of circulating water. Forced draft is, of course, adopted, and there is the usual fan and engine for the purpose. The crew and petty officers have their quarters forward under a roomy turtle-deck, and abaft this, but forward of the boiler, is the cooking compartment and galley.



TORPEDO BOAT FOR THE CHINESE NAVY.

Built by Yarrow & Co, Poplar, England.

In the after part of the boat are the quarters for the officers, consisting of two private sleeping cabins, a large, handsomely fitted saloon, and a pantry; also in a separate compartment a lavatory and other needful fittings. Quite aft there are store-rooms. Steam steering gear is provided in the conning-tower, which forms the termination of the turtle-deck forward of the funnel. The boat can also be steered from aft, as there is a separate wheel and gear for that purpose, fitted specially for the voyage out. The armament is a heavy one, consisting of a pair of torpedo tubes built into the bows underneath the turtle-deck for direct ahead fire, and a single torpedo tube revolving on a turn-table aft, which will discharge on either side and at any required angle. There are three rapid-firing guns, one of which is mounted on the top of the steering or conning-tower, and besides these there are four Gatling six-barreled guns on stands on the after part of the deck. The boat is lighted by electricity throughout; incandescent lamps being used, and a powerful search-light on a traversing carriage is mounted amidships. The dynamo to supply the various lamps is driven by a Parson's high-speed engine, and is placed in the engine-room, where also is the air compressor for charging the torpedoes. On the official trial in the Lower Hope below Gravesend, under the superintendence of Admiral Lang of the Chinese Navy, a mean speed was obtained during six runs, three with and three against tide, of 23.882 knots, and on a subsequent two hours' trial 22.94 knots. She had her armament on board and was in average sea-going trim. After the speed trials had been made, the maneuvering powers were tested, circles being made to port and starboard having diameters of about twice the length of the vessel; the steering qualities equaling those of the No. 79 of the British Navy, which was lately built on a similar model by the same firm.

UNITED STATES NAVAL PROGRESS.

THE naval event of the past month was the launch of the gunboat *Yorktown* and the dynamite cruiser *Vesuvius*, which took place April 28 at the yard of Cramp & Sons, in Philadelphia, in the presence of the Secretary of the Navy and many distinguished guests. The dynamite cruiser was described and illustrated in Captain Zalinski's paper published in our columns last month, but some further account is given below, with a description of the gunboat.

THE DYNAMITE CRUISER.

This cruiser has a displacement of 725 tons; length between perpendiculars, 246 ft.; beam, 26 ft.; mean draft, 9 ft. She is designed for a speed of 20 knots, her engines being of the twin-screw triple-expansion type, developing 3,200 H. P. The cylinders are 21½, 31, and 34 in. in diameter. There are four boilers, 19½ ft. long and 9 ft. diameter, placed in independent fire-rooms. Forward of the fire-room are the quarters for the crew, while the captain's saloon and the ward-room, with state-rooms for four officers, are in the after end of the vessel. She has no spars or sails, and the only projections above the upper deck are the conning-tower and a small superstructure amidships. The conning-tower is built just abaft the guns, and is made of 1-in. steel plates.

The dynamite guns are three in number, placed side by side at an inclination of 16°, projecting a few feet above the deck, near the bow, and extending down nearly to the keel. The lower part of the guns and the crew engaged in loading them are protected by a light water-tight protection deck. The guns are fixed in position—built into the ship—and will be pointed by the helm, the steam-steering engine and the two screws furnishing the power for quick turning. The guns are of 15-in. caliber, throwing shells containing 600 lbs. of explosive gelatine and dynamite; their construction and the method of operating them were very fully explained in Captain Zalinski's paper.

THE GUNBOAT "YORKTOWN."

Gunboat No. 1, named the *Yorktown*, is a twin-screw, coal-protected steel cruiser, with poop and forecastle decks and an open gun deck between. The principal dimensions are: Length between perpendiculars, 226 ft.; draft, 13 ft. forward and 15 ft. aft; breadth of beam, 36 ft.; displacement, 1,703 tons. The rig is that of a three-masted schooner, spreading 6,300 square feet of canvas—sufficient sail power for cruising purposes in times of peace and to insure economy of coal at all times. The two main engines are placed in separate water-tight compartments, and are of the latest triple-expansion type, designed to develop 2,200 H. P. with natural draft and 3,300 H. P. with forced draft, which should give a maximum speed of over 17 knots. The cylinders are 22, 31, and 50 in. in diameter, respectively, with 30-in. stroke, and are fitted with piston-valves. The three-bladed screws are 10½ ft. in diameter. There are four cylindrical horizontal boilers 9 ft. 6 in. in diameter and 17 ft. 6 in. long, having a grate surface of 220 square feet.

The maximum coal capacity is 400 tons, the coal-bunkers being so placed as to protect the boilers and machinery against shot and shell. At a speed of 16 knots the *Yorktown*, starting with her coal-bunkers full, could steam 6½ days and cover a distance of 2,800 miles. At 12 knots speed she can steam 20 days and a distance of 5,750 miles, while at 8 knots she can keep the sea for 62 days and steam 12,000 miles. It will be seen from this that the *Yorktown* will prove a most efficient cruiser, and with her sail power as auxiliary she will be able to maintain herself at sea for months without being compelled to run into port for coal.

In addition to the coal protection for the vitals of the ship, there is a curved water-tight steel deck ⅝ in. thick extending from stem to stern, its crown being at the level of the water-line, while its sides slope to 3 ft. below the water-line, thus forming a turtle-back which gives structural strength as well as security from water which might enter through shot holes above it. At the bow and stern this deck curves down to support the ram and to protect the steering gear. Below this protection deck, or turtle-back, transverse bulkheads divide the under-water body of the ship into 12 main water-tight compartments, while above this deck are several additional compartments furnished with water-tight doors to be closed in battle. The ship will be well lighted throughout with electric lights, there being two sets of dynamos. She will also have two powerful search lights, each of 25,000 candle-power, for use at night.

The armament of the *Yorktown* is very powerful for a ship of her tonnage. The main battery consists of six new high-powered steel breech-loading rifles, caliber 6 in., firing a shot weighing 100 lbs., with a powder charge of 50 lbs. Two of these guns will be mounted forward on the forecastle deck, firing directly ahead and on each side; two aft on the poop deck, firing directly astern and on each quarter, and one on each side of the ship, in the waist, on the spar deck, firing through a large arc, as they are mounted in projecting sponsons. All these guns are furnished with segmental steel shields 3 in. thick, which will afford protection for the guns' crews. The bow and stern guns are 18 ft. and the two waist guns 10 ft. above the water-line. The secondary battery will comprise eight rapid-fire guns and revolving cannon. The torpedo outfit is complete and formidable. There is one fixed tube in the bow to fire directly ahead, one in the stern to fire directly astern, and three training or movable tubes on each side which can be fired within a considerable arc. There is also a complete outfit of boat and spar torpedoes.

The conning-tower of steel 2 in. thick is placed forward on the forecastle deck. It is oval in shape to deflect striking shot, and is furnished with steam-steering wheel, telegraphs, and speaking-tubes. The captain, with a helmsman, will be stationed in this conning-tower to maneuver his ship in battle, to control the firing of guns and torpedoes, and to seize the opportunity for ramming.

The 6-in. guns on board the *Yorktown* will pierce 8 in. of steel-faced armor, or 10 in. of wrought iron, at a distance of 1,000 yards. The machine guns are of the Hotchkiss type, and are also powerful, firing shells weighing 1, 3, and 6 lbs., which will pierce from 1 to 4 in. of armor at close quarters. It will be seen, therefore, that the *Yorktown* could fight the less formidable class of iron-clads, while her light draft of water will enable her to run into comparatively shoal water, and thus escape or choose her distance from an enemy.

THE BATTLE-SHIP "TEXAS."

The accompanying illustrations show the general design of the armored battle-ship *Texas*, which is to be built at the Norfolk Navy Yard. Fig. 1 is a side-view, fig. 2 a plan of the main deck, and fig. 3 a plan of the upper deck. These engravings accompanied a paper read before the British Institute of Naval Architects by Mr. W. John, the designer of the vessel.

The dimensions of the new ship are as follows:

	Ft.	In.
Length between perpendiculars	290	0
Breadth (extreme)	64	1
Depth (moulded to upper deck)	39	8
Mean draft of water	22	6

Displacement at 22 ft. 6 in. draft, when fully equipped and with 500 tons of coal on board, 6,300 tons.

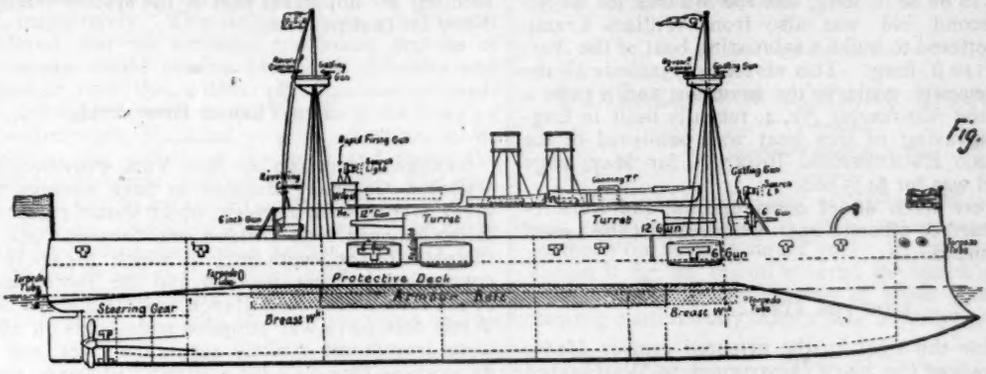
The vessel is to be built on the cellular double-bottom principle. This double-bottom extends under the engines, boilers, and magazines for a length of 158 ft., and is divided both longitudinally and transversely into numerous water-tight compartments fitted for water ballast. Forward and aft a continuation of the double-bottom is formed by the flats of the provision and store-rooms, the extreme ends of the vessel being arranged as trimming tanks. There is a protective deck 3 in. thick extending over the top of the armor belt, and then sloping down forward and aft at the forward end to the point of the ram 10 ft. below the water, and at the after end sufficiently down to protect the steering gear. Below this protective deck there are wing compartments arranged so as to lessen the extent of possible damage of ram or torpedo attacks. The hull of the vessel is to be built of mild steel throughout. Above the top of the belt and the protective deck there are two continuous decks, and the turrets, with the 12-in. guns, are above the upper of these, as seen in the profile. These bulkheads are of 6-in. steel-faced armor. In end-on firing they have, of course, the additional protection of the protective sloping deck, and are, therefore, partly sheltered; and in broadside fighting they must necessarily, from their position, be struck at an oblique angle, if at all. The armor belt is backed up with 6-in. teak, two thicknesses of 25 lbs. plating, rigid framing, and girders. Between the protective deck and the one next above, which we may call the main deck, there is no armor, except round the communications for working and fighting the ship, but the space is divided into water-tight compartments, forming additional coal-bunkers, store-rooms, accommodation for crew, etc. These additional coal-bunkers are further subdivided by water-tight girders longitudinally at a height of 5 ft. above the water-line, and coffer-dams are fitted round the engine and boiler hatches. The main deck carries an armored redoubt, surrounding the lower part of the turrets, and the hydraulic machinery for moving and loading the guns. The redoubt and turrets are of 12-in. steel-faced armor, with 6-in. teak backing, well supported, and the top plating, which forms part of the upper or weather deck, is 1 in. thick. The main battery consists of two 12-in. guns in the turrets just men-

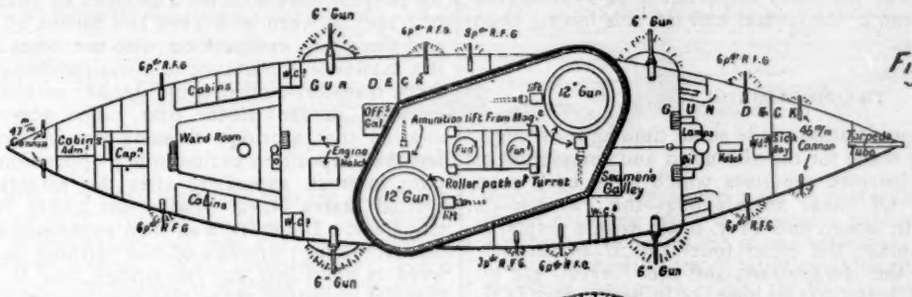
tioned, and six 6-in. guns protected by shields. The turrets are placed *en échelon*, so as to permit of a fore-and-aft fire. Each 12-in. gun has a complete broadside fire on one side, and has a train on the opposite side of 40° for the forward gun and 70° for the after gun. One 6-in. gun is placed forward and one aft on the same level as the 12-in. guns, having each a train of 120°. The remaining four 6-in. guns are mounted in sponsons of the main deck, two having a train from directly forward to 25° abaft the beam, and two from directly aft to 25° forward the beam.

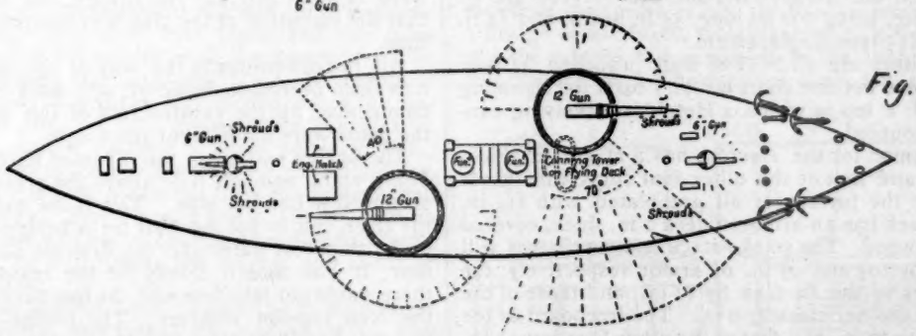
On the main deck the secondary battery consists of four 6-pounder Hotchkiss rapid-firing guns; four 3 pounders, and four 47-mm. Hotchkiss revolving cannon, protected by 1½-in. steel plating. Two Gatlings and two 37-mm. guns are placed on the bridge deck, and two 1-pounder Hotchkiss guns are placed on the flying bridge. Two

The space between the upper and main decks not appropriated by the redoubt and the secondary battery is taken up by the quarters of the officers and crew, which are well lighted and ventilated. Access to the redoubt and turrets is obtained from the protective deck. Steam and hand-steering gear is fitted below the protective deck, and steering connections are made with them from the conning-tower, after wheel-house, and flying bridge. The communications from the conning-tower for navigating the vessel are protected by an armored tube 3 in. thick.

The ship will have twin screws, driven by two triple-expansion engines placed in separate water-tight compartments. The engines will have cylinders 36, 51, and 78 in. diameter, with 39-in. stroke. Steam will be supplied by four double-ended boilers 14 ft. diameter and 17 ft. long. The working pressure will be 150 lbs., and it it is expected







ARMORED BATTLE SHIP "TEXAS," UNITED STATES NAVY.

Gatlings with two 37-mm. revolving cannon are fought in the military mast tops to repel boarders and torpedo-boat attacks. Two 37-mm. guns are further fitted in the steam cutters. The magazines for the main battery are placed in the center of the vessel below the protective deck. The ammunition for the secondary battery is stowed in magazines placed forward and aft, the ammunition being passed up to the main deck through an armored tube 3 in. thick. Torpedoes can be projected through six tubes—one through the bow, one through the stern, two through the side aft above water, and two through the side forward below water. Air compressors are to be fitted forward and aft, and stowage room is provided for 14 torpedoes. Stowage room is also arranged for submarine mines.

The ship will be provided with four large electric search lights, besides two smaller ones for the boats.

that under forced draft, with an air pressure of 2 in. of water, they will supply steam enough to enable the engines to develop 8,600 H. P.

At the normal draft of 22 ft. 6 in. the coal supply will be 500 tons. The endurance—that is, the distance the ship can steam at various speeds, with this supply and with the fuller load of 850 tons of coal, which can be carried, is as follows:

Speed.	On 500 tons.	On 850 tons.
17 knots per hour	1,110 knots.	2,180 knots.
15 " "	2,050 "	3,900 "
13 " "	3,170 "	6,000 "

The quarters for officers and crew will be of ample size and well ventilated. Proper ventilation for the magazines will also be provided.

THE NAVAL RESERVE.

The Secretary of the Navy has presented to the Naval Committee of the House of Representatives an argument in favor of some action as to the establishment of a naval reserve. So many other matters are pressing upon the attention of Congress just now, that the probabilities are that nothing will be done on this question at the present session.

THE SUBMARINE TORPEDO-BOAT.

The bids for the submarine torpedo-boat were opened at the Navy Department in Washington, May 3. They were two in number: one from William Cramp & Sons, of Philadelphia, for a submarine boat of the same type as the *Nautilus*, designed by Mr. Holland, of New York, and Captain E. L. Zalinski. This boat, according to the plans submitted, is to be 88 ft. long, and the bid was for $135,000. The second bid was also from William Cramp & Sons, who offered to build a submarine boat of the *Nordenfelt* type, 120 ft. long. This vessel is to include all the latest improvements made by the inventor, and is to be a duplicate of the *Nordenfelt No.* 4, recently built in England. An engraving of this boat was published in the RAILROAD AND ENGINEERING JOURNAL for May, page 210. The bid was for $135,000.

The bids were taken under consideration, and were referred to a board of officers, upon whose report the award will be announced.

BIDS FOR STEEL.

Proposals for the steel for the armored cruiser *Maine* will be received at the Navy Department in Washington until noon of June 4, the formal call for bids having been issued on May 4.

THE MONITOR CLASS.

Under the appropriation made some time ago, arrangements are being made for the alteration and completion of the five double-turreted monitors which were built soon after the war. Of these vessels one—the *Puritan*—is 296 ft. long, 60 ft. beam, and 18 ft. draft, with a displacement of 6,000 tons; the other four—the *Miantonomoh*, the *Monadnock*, the *Amphitrite*, and the *Terror*—are all of the same size, being 262 ft. long, 55 ft. beam, and 14 ft. draft, with 3,815 tons displacement.

These monitors are all built of iron, propelled by twin screws, and have but one short military mast for signaling purposes, with a top in which a Hotchkiss revolving cannon will be mounted.

The side armor for the *Puritan* has a maximum thickness of 12 in. and that of the other four ships a thickness of 7 in., while the turrets for all are plated with 11½ in. of steel, and each has an armored deck 2 in. thick, covered with 3½ in. of wood. The smoke-stack and ventilators will be protected by 10½ and 9½ in. of armor respectively, the conning-towers of the *Puritan* by 12 in., and those of the *Miantonomoh* and her class by 9 in. The freeboard of the *Puritan* will be 30 in. and that of the other four but 25 in. All will be armed alike. The main battery will consist of four 10-in. steel breech-loading rifles firing a projectile weighing 500 lbs., with a powder charge of 250 lbs. The secondary battery will comprise two 6-pounder, two 3-pounder, two 1-pounder Hotchkiss guns, and two Gatlings.

As a protection against torpedo attacks, nets are provided made of steel rings to be rigged out from the side some distance, hanging down into the water, with electric search lights for use at night.

Several important changes will be made as a result of the improvements made in naval architecture since the *Monitor* was originally designed. Formerly the turrets rested on the upper deck, from which they were lifted by a central spindle and revolved by steam to bring the guns to bear as desired. As modified, the turrets will pass through the upper deck and rest upon conical rollers on the next deck below, thus affording protection to the machinery and diminishing the liability to jam. Surmounting the turret is a conical armored pilot-house so constructed as to deflect a striking shot, and above the pilot-house, resting on iron stanchions over each turret, are light circular wooden houses containing quarters for officers in addition to those below decks. The tops of the turrets are connected by a hurricane deck where hammocks and boats will be stowed and the machine guns mounted. This deck is supported on combined stanchions and ventilators which allow for passage to the water which will flow across the main deck in heavy weather at sea. The *Puritan* is divided into 100 water-tight compartments, and the other ships each into 87.

These vessels will all be provided with sufficient quarters for officers and crew, with ample ventilation; they will have a full equipment of electric lights. The *Terror* is to have pneumatic apparatus for handling guns and turrets, and also pneumatic steering machinery.

These ships are to be used chiefly for coast defense, forming an important part of the system arranged by the Navy for that purpose.

The Thames River Bridge.

SEVERAL years ago the New York, Providence & Boston Railroad Company decided to have surveys made and plans prepared for a bridge, which should cross the Thames River between New London and Groton, Conn., and take the place of the steam ferry by which, for many years, the connection between its road and the Shore Line Division of the New York, New Haven & Hartford has been made. While this ferry was supplied with boats on which trains were transferred directly across the river, and answered its purpose very well for a number of years, the increase of travel between New York and Boston by the Shore Line and the sharp competition with the other rail lines made it a matter of importance to avoid the delay incident of the ferry transfer, and also the danger of obstruction of the crossing in the winter time. The surveys then made showed that a bridge crossing was perfectly practicable, but the proposition excited much opposition from the shipping interest, especially after the establishment of the United States Naval Station just above New London on the river. Difficulty was also experienced in arranging the conflicting interests of the railroad companies which were to build and use the bridge, and it thus happened that the execution of the plan was postponed from time to time.

All the difficulties in the way of the construction have now been overcome, however, and work has actually been commenced on the substructure of this bridge, for which the plans were made eight years ago.

The bridge will cross the Thames River at Winthrop's Point, about one-half mile above the present ferry landing on the New London side. This is the narrowest place on the river, but is not the best for a bridge crossing, owing to the depth of water and the difficult nature of the bottom; it was chosen chiefly for the reason that a bridge there would not interfere with the free access of shipping to the New London wharves. The bridge is, however, below the Naval Station, and the length of the draw-span was fixed by the Government engineers so as to leave openings of sufficient width to permit the passage of the largest vessels now used or likely to be used in the Navy, as well as of the large steamboats which ply the river.

Beginning on the western, or New London side, the bridge will consist of one deck-span 150 ft. long; one fixed-through span 310 ft. long; one draw-span 502 ft. long, leaving a clear opening of 225 ft. on each side of the center pier; one through-span 310 ft. long, and one deck-span 150 ft. The total length of the superstructure will thus be 1422 ft. The draw-span, as will be seen, will be one of the largest, if not the largest, in the country, exceeding by some 70 ft. in length the great draw-span of the bridge over the Raritan between Perth Amboy and South Amboy on the New York & Long Branch road, which was at the time of its construction the largest in the world. The superstructure will be entirely of steel, and will present no special peculiarity of design. The draw-span will be operated by a steam-engine, and will be so

arranged as to open and close very quickly. The bridge will be built for a double track, and there will be a clear headway below it of 30 ft. at high tide, so that many small vessels will be able to pass without making it necessary to open the draw. The accompanying engraving is an outline sketch of the bridge, showing its general dimensions.

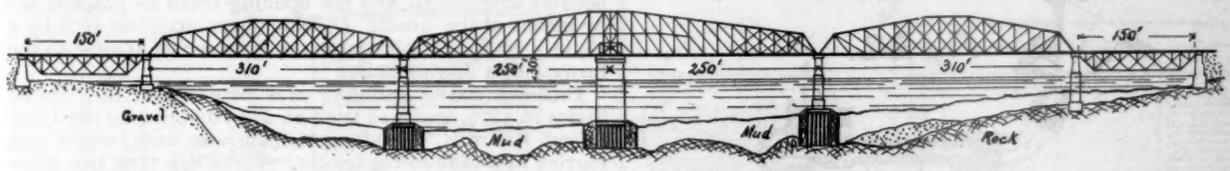
The substructure of the bridge required careful consideration on account of the great depth of water and mud found before a solid bottom was reached. The western abutment and pier No. 1 on the western side presented no special difficulties, as the depth of water at that side of the river is small, as shown in the sketch, and the masonry foundations will require merely the driving of a few short piles in the bed of coarse gravel, which at that point overlies the rock. Pier No. 2, pier No. 3 (the draw-pier), and pier No. 4, however, presented a difficult problem, the depth of mud and water at these points being 150, 128, and 130 ft. respectively. This depth was so great that it was considered that the ordinary pneumatic process of sinking caissons would involve too much difficulty and expense; and, to avoid this, another plan has been adopted. This is to sink into the mud at the bottom of the river an immense timber curb, fill it full of piles which are to be cut off even at the surface of the mud, and found the masonry upon a platform built on these piles. The mud within the curbs will be excavated or dredged out, and the spaces around the piles filled with concrete. The curbs will be sunk by loading them with ballast, for which purpose pockets will be left in them when built.

The curb for the center pier, No. 3 (the draw-pier), will be 71 ft. square and 79 ft. high; that for pier No. 2 will be 49 by 79 ft. in size and 85 ft. high, and that for pier No. 4 will be also 49 by 79 ft., but only 69 ft. high. The depth of water at all of these piers will not vary very far from 30 ft. above the mud bottom. In the accompanying sketch a general idea of the arrangement of these curbs is given. The curbs having been sunk into place and the piles driven and cut off at the proper level, the masonry will be built in open caissons and sunk into place, the bottom of the caisson forming a grillage for the support of the masonry. For pier No. 3 a base course of masonry 42 ft. square will be carried up with a slight batter to 38 ft., when it will change to the circular form of 36 ft. diameter. The masonry of this pier, measured from the grillage, will be about 75 ft. high. Piers Nos. 2 and 4 will be built in the same way, but will be, of course, of a different form, being about 42 by 8 ft. under the coping, and about 50 by 20 ft. at the base.

The masonry of pier No. 2 will be about 90 ft. high above the top of the piling, and that of No. 4 about 75 ft. Pier No. 5 requires no special description, the depth of water at that point being only about 20 ft., and the mud about the same, so that it has only to be carried down about 40 ft. before reaching a solid bottom. The east abutment also, like the west one, will not be difficult of construction, the mud at that point being 14 ft. and the water 12 ft. above the solid bottom. Both these piers will be built in open caissons sunk on a concrete foundation made by a timber crib sunk through the mud to the rock bottom. All the masonry will be of granite.

The preliminary surveys and plans for the bridge were made by Mr. Alfred P. Boller, of New York, who has had entire charge of the work since the construction of the bridge was first proposed. The contract for the bridge has been let to the Union Bridge Company of New York. That Company will build the superstructure, and has sublet the contract for the foundations and masonry to Mr. Alexander McGaw, of Philadelphia. The surveys for the bridge have been of a very complete character, and have included an immense number of borings at different points along the river, made in order to ascertain the exact nature of the bottom. As above said, however, the final location of the bridge was determined rather by other considerations than by the nature of the ground.

The western approach to the bridge will be made by a line running from the present Union Station in New London through the eastern part of the city, nearly parallel with the track of the New London Northern Railroad, and turning eastward by a sharp curve nearly opposite the western end of the bridge; the New London Northern track will be crossed overhead near the bridge. On the eastern side a new line will be built from the end of the bridge to Noank, on the New York, Providence & Boston Railroad, which will be somewhat shorter than the present line, and will be also a better line, avoiding several of the sharp curves in the old road. The present steam ferry will be abandoned, at least for the transfer of cars, as soon as the bridge is completed.



THE THAMES RIVER BRIDGE.

FURNACES FOR BURNING LIQUID FUEL.

(*Continued from page 219.*)

3. THE nozzle sprinkler of Aydon, Wise & Field was first tried in England in 1866, and is one of the oldest methods for burning liquid fuel. In this burner, which is shown in fig. 20, the oil entered the sprinkler from a vertical pipe through an opening of about ⅛ in. in diameter, flowing continuously from a tank at a higher level. It was forced into a discharge pipe by a stream of superheated steam escaping from a horizontal pipe, which sucked in air from a funnel on top of the sprinkler. The oil, steam, and air were discharged together through the cone-shaped mouth of the sprinkler into the fire-box, and struck against a bridge of fire-brick, which served to still further distribute the stream and expose it to the heat, thus securing full combustion. The supplies of oil, air, and steam were

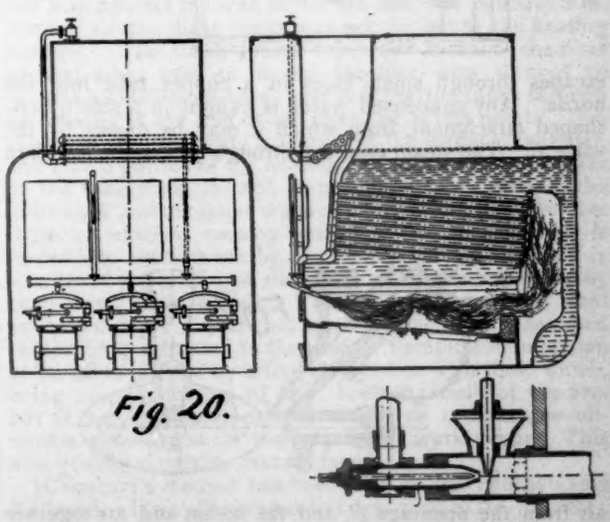
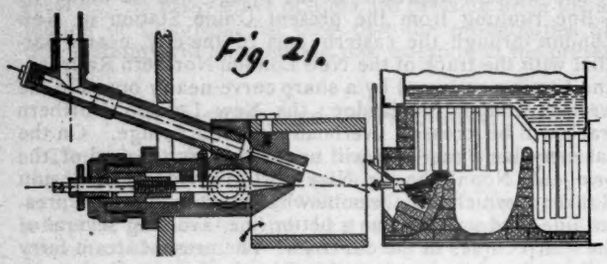


Fig. 20.

regulated separately. This contrivance was tried for some time, but did not come into any extended use.

The nozzle sprinkler of Aydon and Selwyn, shown in fig. 21, was a modification of the apparatus mentioned above, and was used in a marine boiler in some trials conducted by the English Admiralty in 1868. The chief modification from the former apparatus was an arrangement made by

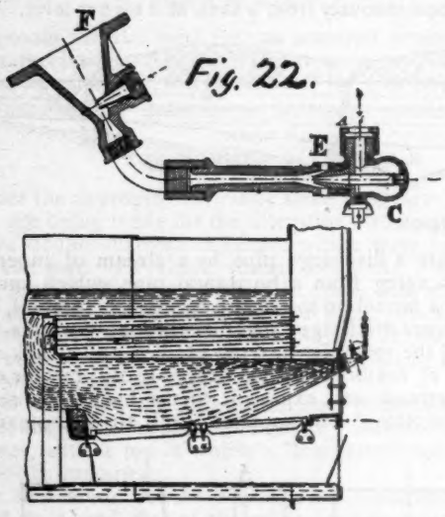
which the oil and steam met at an acute angle instead of a right angle. This was tried both with and without bridges in the fire-box, and the trials were so far successful that the apparatus was placed in the boilers of the British naval



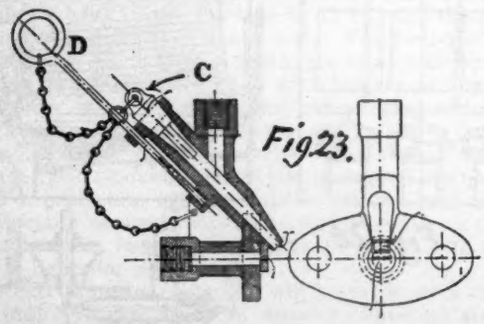
steamer *Oberon*. In this boiler it is claimed that very satisfactory results were obtained, and practically a perfect combustion of the oil.

The experiments were not continued, however, probably owing to the high price of oil at that time. It is to be noted, however, that these inventors first introduced nozzle sprinklers, to which a return has now been made after trying a number of other methods.

The nozzle sprinkler of Korting, shown in fig. 22, was introduced in 1876, and was arranged to be used in boilers without any alteration of the fire-boxes. All that was necessary was to fasten it to the side of the fire-door. In this device steam is admitted into the sprinkler through the opening *A*, and enters a compartment from which it

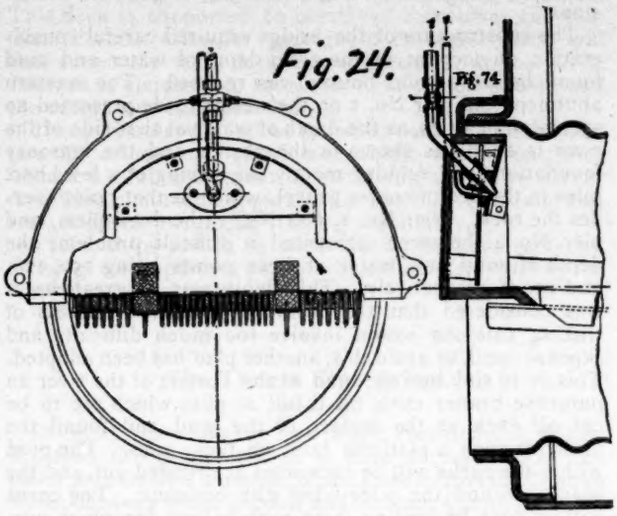


escapes through small holes in a copper tube into the nozzle. Any condensed water is caught in a small, bell-shaped attachment, from which it may be drawn by the valve *C*. The steam entering through this nozzle draws in



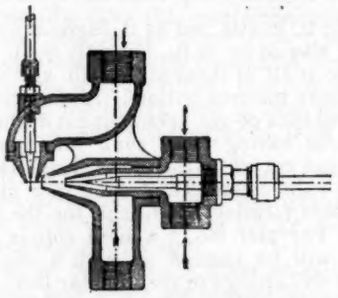
air from the openings *E*, and the steam and air together vaporize the oil in a spray from the mouthpiece *F*. The oil flows into the mouthpiece through the openings shown in the side, which are of about ¼ in. in diameter. The flow of oil, steam, and air can be regulated by valves. The flame is blown into the fire-box at an angle, as shown in the section of the boiler. The difficulty with this apparatus was, apparently, that the steam jet was not sufficiently powerful, and that the oil was not sufficiently separated to secure perfect combustion.

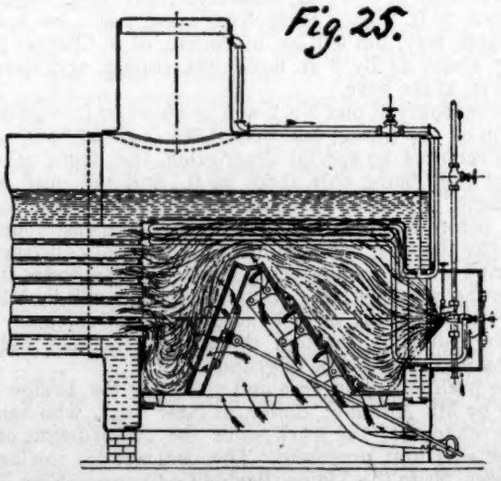
Some years later Korting introduced a modification of this apparatus, which is shown in fig. 23. In this the oil flowed out of a slit-like opening and was vaporized by the



steam jets, which met it at an acute angle. The steam issued from several small orifices from $\frac{1}{16}$ to $\frac{1}{8}$ in. in diameter. The stopper *C* could be drawn out should the nozzle become stopped up, and the opening could be cleaned out by means of the needle *D*, which was attached to it by a chain. In fig. 24 this apparatus is shown as applied to the furnace of a marine boiler.

Dickey's nozzle sprinkler was patented in the United States in 1878, and was tried on a locomotive on the Long Island Railroad. Crude petroleum was used, which was carried in a tank in the tender. From this tank two pipes led to the fire-box, each of them ending in a sprinkler,





from the nozzle of which oil issued at a low pressure. Superheated steam was introduced by a nozzle placed at right angles to the oil-pipe, and air was drawn in through a pipe projecting underneath the fire-box by the action of the steam jet. The oil, steam, and air were blown against

a number of cast-iron plates arranged like Venetian blinds, through the openings of which additional air was admitted. These openings could be enlarged or reduced at pleasure. This apparatus, which is shown in fig. 25, was placed in a grate of an ordinary coal-burning engine, and, it was claimed, secured a very complete and even heating of the fire-box. At the trials it was said the combustion was very good; no smoke escaped through the stack. The trials were not continued, however, and the apparatus was not further introduced. In this case, as in many others, the relative prices of coal and oil probably had much to do in determining the result.

A nozzle sprinkler arranged by Mr. Urquhart was tried in 1874 on the Gryasi-Tsaritzin Railroad in Russia; it is shown in fig. 26. In this the oil was carried through a tube into a horizontal pipe running along the wall of the

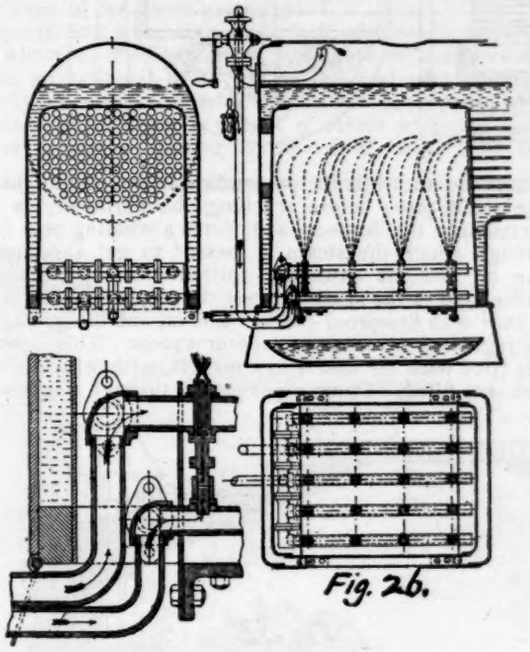


Fig. 26.

fire-box, to which five other horizontal parallel pipes were connected. Under each of these pipes was a steam-pipe

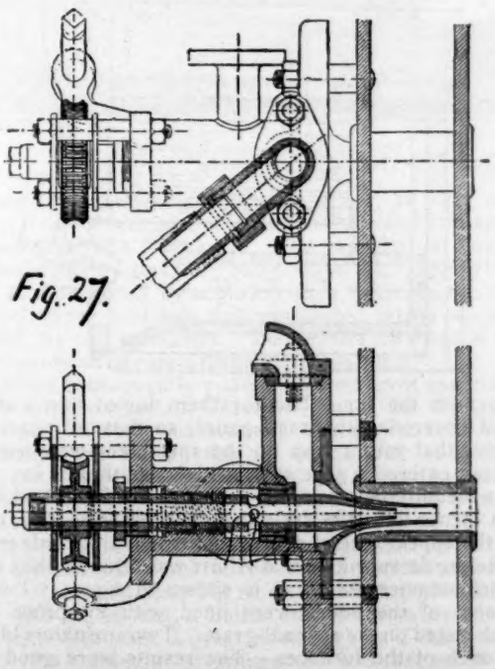
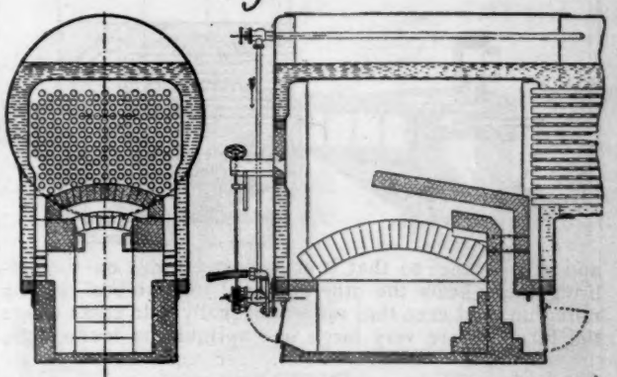


Fig. 27.

taking steam from the boiler, and so arranged that steam and air would pass through the nozzle and carry the oil in a circular spray of vapor into the fire. Any oil unconsumed dropped into a pan of water carried in the ash-pan. This arrangement was not found to be economical, however, and it was subsequently given up for an improved system devised by Mr. Urquhart.

A later device of Urquhart is shown in fig. 27. In this the oil passes from tanks in the tender by means of a tube and a pipe into the sprinkler. The non-superheated steam leaves the dome of the boiler and enters the sprinkler; it passes through orifices into the interior of a bronze spindle and escapes through the front of the nozzle. A spiral wheel which moves on a spring in a groove regulates the outlets for the oil. To obtain the requisite air the sprinkler is fixed so as to protrude into a pipe-rest, and a space of about 1 in. is allowed between the flange of the sprinkler and the plate of the boiler. The oil and steam are separated inside the sprinkler by means of a box filled with asbestos packing, which latter has to be renewed about once a month. The admission of steam is regulated by a special valve in the pipe. The results were found to be so good that 140 locomotives on the Gryasi-Tsaritzin Railroad are now fitted with it. Should this sprinkler get stopped up for any reason the spindle has only to be screwed back, and the oil will force the carbonized particles into the fire-box. Urquhart has also protected the walls of the pipe against the flames, and prevented all the deteriorating action on the boiler which their direct action entails, by lining the inside of the fire-box with brick, as shown in fig. 28. Here the sprinkler is placed low down, and blows into a furnace chamber built into the fire-box and covered with a vaulted roof, which slants off

Fig. 28.



in the direction of the tube plate. The brickwork does not lean against the wall of the fire-box, but is about 2 in. from it, so that these walls may not be lost to the heating surface. The flame beats from the furnace chamber against what used to be the fire-door, now bricked up (except a small peep-hole), and reaches the tubes through an opening in the roof of the chamber at this point. Two channels are built into the walls of the furnace chamber, and lead a portion of the heating gases to the lower surface of the tube-plate, as well as into the spaces between the brickwork and the outer walls of the fire-box, so as to give these an efficient heating surface. The requisite air is forced into the furnace by the sprinkler, and more air is admitted by the ash-pan dampers, which are regulated by chains and chain-wheels. The air entering at the front ash-pan damper passes through a channel, and is warmed before being admitted to the gases. Complete combustion of the oil is insured by fitting the fire-box with tiles, which, being non-conductors of heat, keep the walls of the fire-box at an equal temperature, and even re-light the oil-stream should a short interruption of work occur. This also greatly simplifies management.

[Urquhart's method has been tried on the Pennsylvania Railroad. It was illustrated and described in the JOURNAL for August, 1887.]

Spakovski's nozzle sprinkler, shown in fig. 29, has been used on steamers on the Caspian Sea. The liquid fuel, in this case oil residuals, flows out of the inner nozzle, which protrudes into the mixing pipe 0.04 in.; the steam escapes through the circular opening surrounding this nozzle. Air is admitted through holes in the circumference of the mixing-pipe; the mixing pipe prevents the great air expansion

of the steam jet and thus slightly aids the vaporization of the oil; but this is not done so efficiently in the case of the Spakovski apparatus as in that of Urquhart's latest improvement. The steam jet surrounding the oil only acts strongly from underneath; the upper part expands without materially aiding the vaporization, so that by looking through a piece of blackened glass drops of fluid oil can be observed falling into the furnace, where they are burnt up in their fluid state. The flame has a broom-like shape,

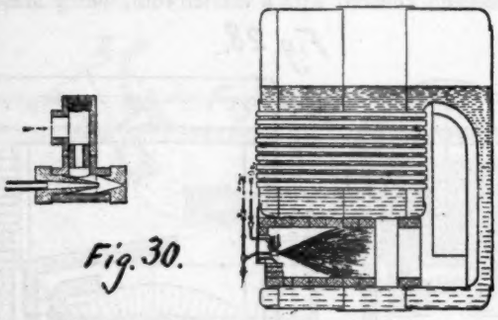


Fig. 30.

and is very long, so that it acts most forcibly on the fire-bridge, and heats the other parts of the fire-box only by radiation, and even that rather unequally. In cases where the furnaces are very large one sprinkler is inadequate,

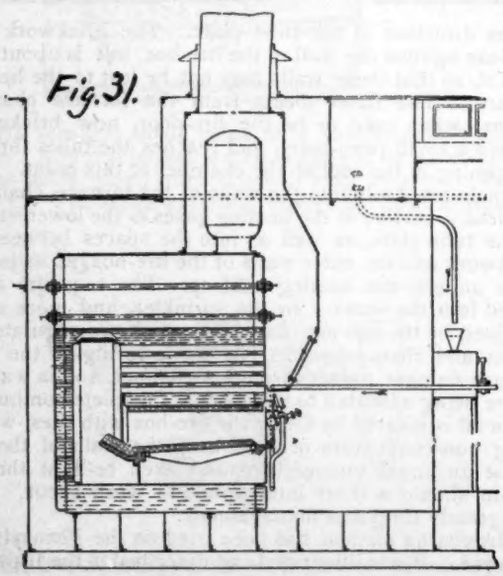


Fig. 31.

and two or three have to be fitted, which causes complication. The supply of oil and steam is regulated by means of separate valves for each sprinkler. The first trials with this apparatus showed an excessive consumption of oil, but with subsequent improvements made much better results were obtained.

Sadler's nozzle sprinkler, shown in fig. 30, is a very simple one. It consists of two small bronze nozzles, which are screwed on to the opposite ends of a T-shaped malleable iron pipe. Another T-shaped pipe is screwed into the third orifice of the first, and the horizontal pipe of this

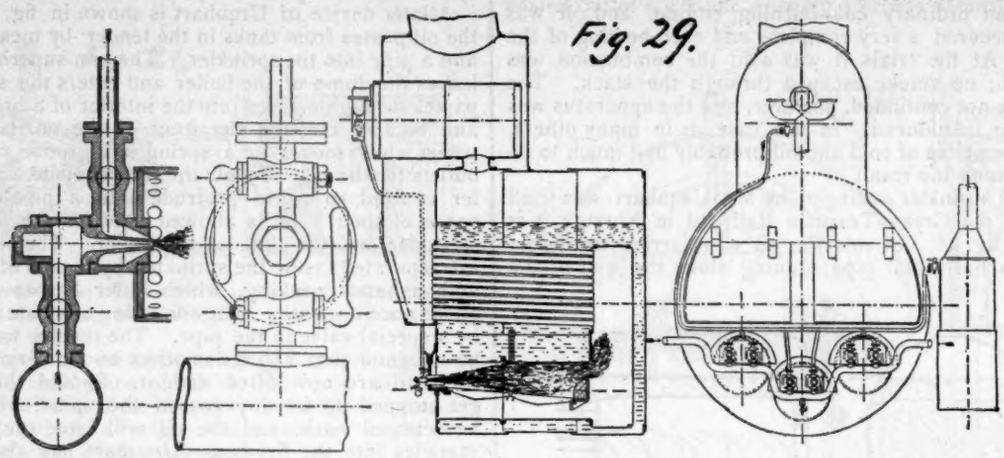


Fig. 29.

admits the oil, while the perpendicular end admits the air. The steam-pipe, before reaching the sprinkler, is conducted into the furnace, and forms a winding pipe there, through which the steam is passed to get superheated. The oil and air enter the sprinkler through the same orifice, and in the space between the nozzles. The furnace is lined with fire-proof brick. The oil and steam supplies are regulated by separate taps or valves. This sprinkler was tried with tar and heavy tar oils, with which a large tank was filled. Steam-pipes passed through this tank, so

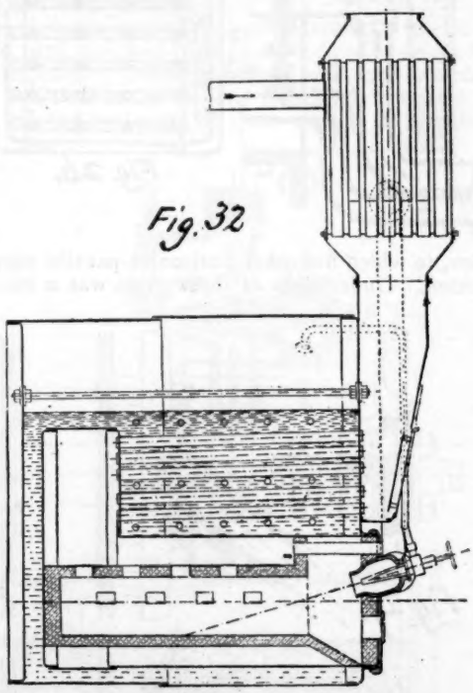


Fig. 32.

as to melt the tar. The tar then flowed into a smaller vessel covered with brass gauze, so that all coarse impurities that might stop up the sprinklers were arrested. The tar entered a pipe with a clear width of 2 in., which had a steam-pipe 0.4 in. in diameter inside it, and flowed from thence into the sprinkler. On entering this the tar had the appearance of a dark and rather thick mineral oil.

The nozzle sprinkler of d'Allest was tried in 1885 on the French steamer *Aude*; it is shown in fig. 31. Both the furnaces of the boiler were lined with fire-proof brick, which rested on the old coal-grate. Two sprinklers blew oil into each of the furnaces. The results were good so far as combustion was concerned, but the sprinkler consumed an abnormally large quantity of steam, as much as from 8 to 10 per cent. of the entire steam consumption. D'Allest

then tried to vaporize the oil by means of compressed air instead of steam, to avoid the enormous loss of the latter. But the first experiments of this kind were not successful, because the blowers would not give sufficient pressure. In 1886 further experiments were made. In these the air was pressed by an air-pump into a cylindrical tank, and was conducted from thence to the sprinklers, where it must have retained a considerable pressure. The oil flowed from a tank into the sprinklers in the boiler. The results of these experiments showed that the combustion of oil is much more perfect when it is vaporized by compressed air than when vaporized by steam, as, indeed, was proved by the increased whiteness of the flame. The best results were obtained with hot air; in vaporizing with cold air the walls of the furnace must be lined with fire-proof brick, otherwise the flame is nearly extinguished. The weight of air necessary to work the sprinkler amounted to about 5 per cent. of the steam generated.

Experiments were also made with the nozzle sprinkler of d'Allest to see whether oil fuel could be used in cases where an artificial draft was raised, and when it is especially necessary, as with the boilers of torpedo-boats, to generate as great a weight of steam as possible per square meter of heating surface per hour. For this purpose the arrangements shown in fig. 32 were made. A clay receiver was placed in the furnace and two sprinklers were fitted in front of it. The vaporization could be effected either by steam or compressed air. The artificial draft was produced by a blower in a heater in the throat of the chimney, and was then conducted into a box which encased the two sprinklers. The results obtained in these experiments were very satisfactory, it is said.

D'Allest subsequently conducted a series of experiments on the torpedo-boat *La Chevrette*, under the direction of the French Ministry of Marine. He at first tried to use compressed air to vaporize the oil as well as to supply draft, but this proved unsuccessful and he had to return to the use of steam. In a torpedo-boat boiler it is necessary to obtain a high evaporation in a small boiler. D'Allest claims that he secured this, and further, that he had complete combustion of the oil both with natural and forced draft. He stated that the result of his experiments was that, with oil as fuel, a boiler one-fifth smaller could be used than with coal, a great advantage in a vessel of this class. An incidental advantage also was that when burning oil with forced draft the flues were never stopped up, as they frequently were with coal.

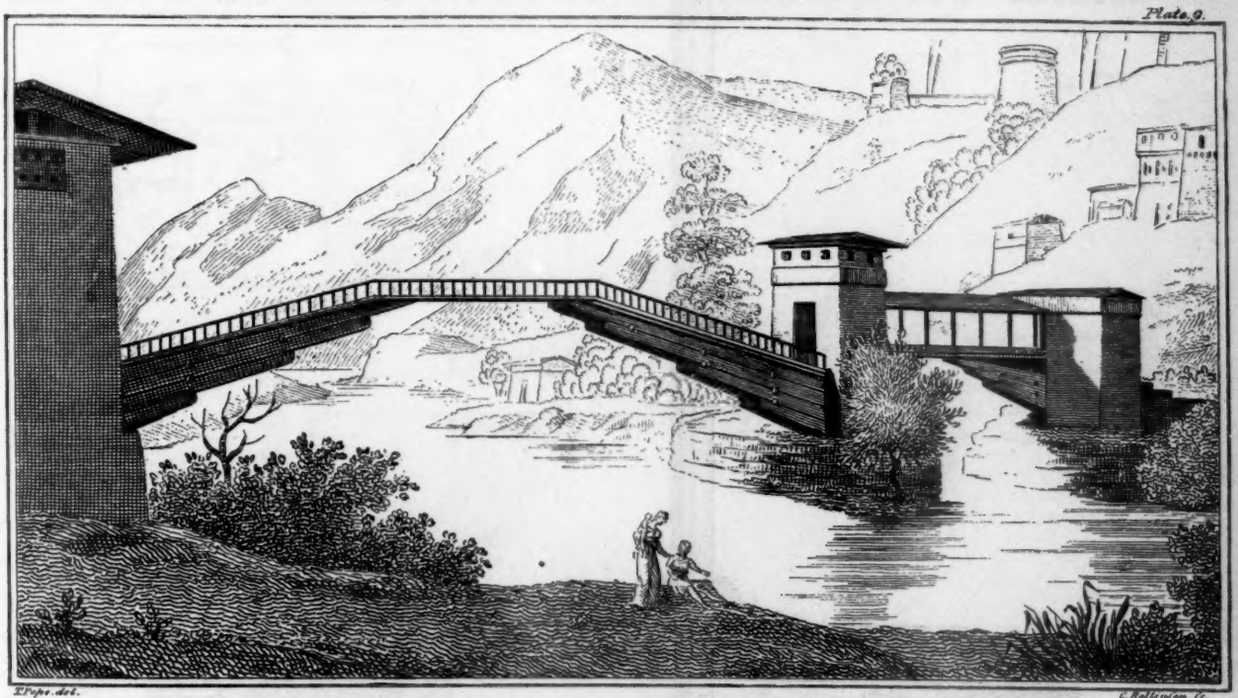
There seems to be no doubt of the superiority of liquid fuel in many cases of this kind, where the room allowed both for boilers and for storage of fuel is limited.

An Ancient Cantilever Bridge.

In the very curious "Treatise on Bridge Architecture," published by Thomas Pope in 1811 (to which reference was made last month), there is given an engraving and description of a bridge which is, so far as we know, the oldest example of a cantilever bridge on record. The description is taken by Mr. Pope from a still older work, Turner's "History of the Embassy to Thibet;" and though the date of the structure is not definitely given, it would appear from the references made that it must have been built more than two centuries ago. We reproduce herewith the illustration and description.

The Bridge at Wandipore is of singular lightness and beauty in its appearance. It is composed entirely of fir,

Plate 9.



T.Pope. del. C.Rollinson. Sc.

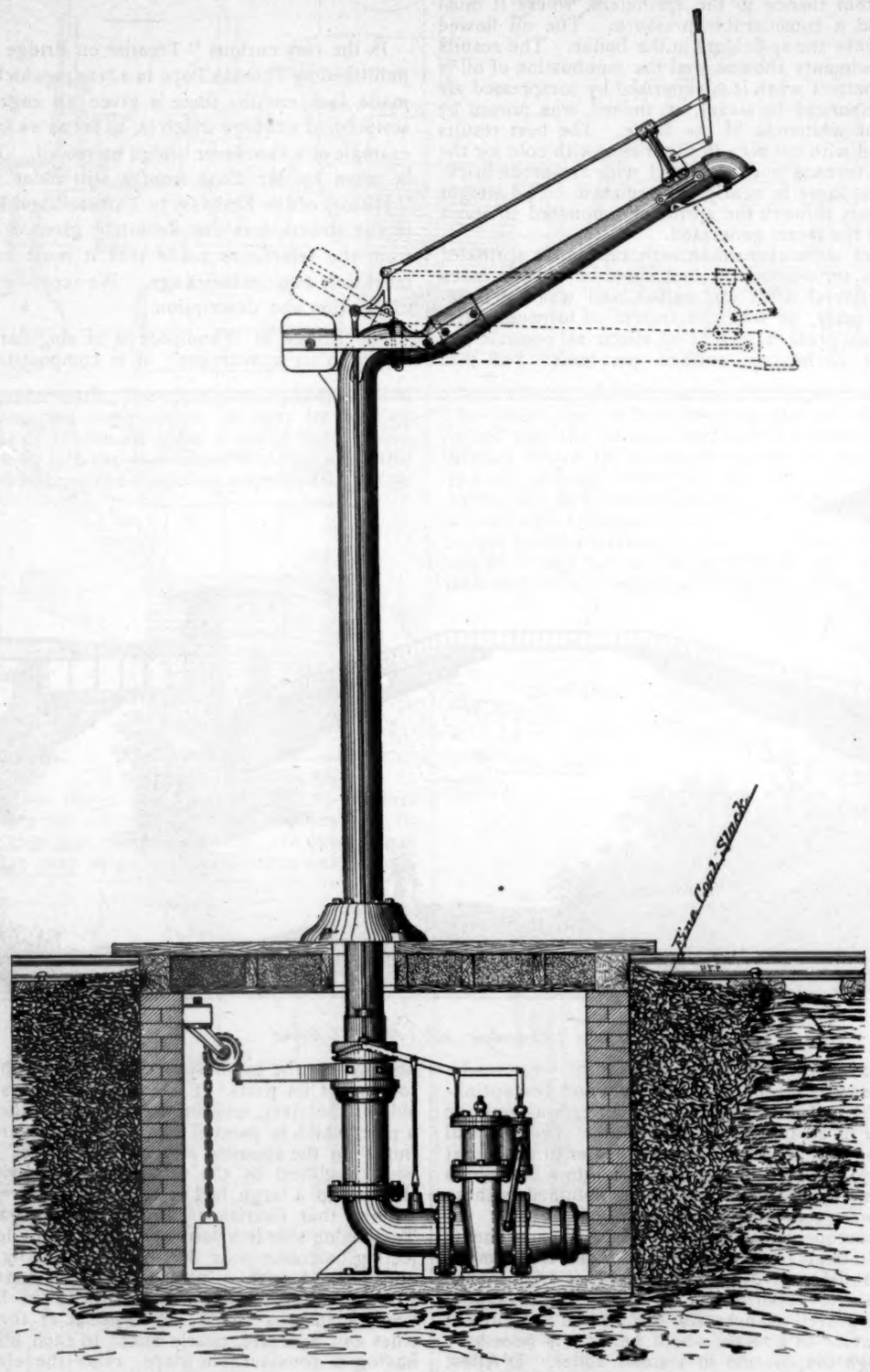
The Bridge at Wandipore

and has not the smallest piece of iron, or any other metal, to connect its parts; it has three gateways; one on each side of the river, and another erected in the stream, upon a pier, which is pointed like a wedge toward the current, but is on the opposite side a little convex; below it, the eddy produced by the reunion of the divided water has thrown up a large bed of sand, on which grows a large willow, that flourishes extremely. The gateway on the Tassisudon side is a lofty square stone building with projecting balconies near the top, bordered by a breastwork, and pierced with a portcullis. The span of the first Bridge, which occupies two-thirds of the breadth of the river, measures 112 ft.; it consists of three parts, two sides and a center, nearly equal to each other; the sides having a considerable slope, raise the elevation of the center platform, which is horizontal, some feet above the floor of the gateways. A quadruple row of timbers, their ends being set in the masonry of the bank and pier, supports the sides; the center part is laid from one side to the other. The beams and planks are both of hewn fir; and they are pinned together by large wooden pegs. This is all the fastening I could observe; it is secured by a neat light rail. The Bridge, from the pier to the hill, is horizontal, and the beams rest on the pier and on a triple row

of timbers let into the bank; it has a penthouse over it, which is covered with shingles. The sound state of this Bridge is a striking instance of the durability of the turpentine fir; for, without the application of any composition in use for the preservation of wood, it has stood exposed to the changes of the seasons for near a century and a half, without exhibiting any symptoms of decay, or suffering any injury from the weather.

Improved Automatic Stand-Pipe.

THE accompanying illustration shows an improved form of railroad stand-pipe recently introduced by the Sheffield Velocipede Car Company at Three Rivers, Mich. Its construction will be readily understood from the engraving. It includes the main features of the plain pipe heretofore



IMPROVED AUTOMATIC RAILROAD STAND-PIPE.

Made by the Sheffield Velocipede Car Co., Three Rivers, Mich.

made by the same company, which is now extensively used. These include the flexible joint and elevating spout, combined with a rotating column; the elevation of the spout retains the drip, so that the ground around the stand-pipe is not wet and muddy in summer or covered with ice in winter, the column being freed from water by a waste valve which works automatically.

The special feature of the automatic pipe is the use made of the pressure always on the pipe to open and close the valve. This is effected by the use of a cylinder above the valve, in which is a piston connected to the valve itself; this piston can be moved up or down at will by means of the auxiliary valve attached to the main cylinder, the operator or fireman being thus enabled to throw the pressure of the water on either side of the piston, as desired.

The difficulty usually found with stand-pipes operated by the fireman from the tender has been the amount of mechanism necessary to work the valve, and the strength required to open and close it. In this pipe the machinery is very simple, and is only required to operate a small auxiliary valve which admits water into the main cylinder, and thus moves the valve proper. The auxiliary cylinder is so arranged that the valve of the stand-pipe may be opened rapidly and closed very slowly, as desired; this obviates the shocks given to the pipe by too rapid closing, and at the same time gives a quick opening.

The spout is balanced by a counterweight, which holds it in an elevated position when not in use, as shown in the cut. The same kind of a device also holds the pipe in line with the track when it is not needed for watering, thus obviating all chance of the spout being blown around by wind or thrown around by careless or malicious persons into a position where it might be struck by a passing train.

The distinctive features of this form of stand-pipe are covered by patents. It is in use at several points with excellent results.

A Marine Brake.—Experiments have been recently made on the Seine, in the stoppage of steamers in motion, by means of a "cable-anchor" invented by M. Pagan. This is a cable having on it a series of canvas cones, which open out by the action of the water, and close again when drawn in the opposite way. The steamer *Corsaire*, running 13 knots, was stopped each time by the apparatus in seven or eight seconds, and in a space of 26 to 30 ft. at the most. For comparison, the steamer, running full speed, was stopped in the usual way, by reversal of the engines. This took at least 34 seconds, and the space was 350 to 360 ft. It would thus appear that M. Pagan's apparatus effects the result in less than a tenth of the space, and a fourth of the time, of the ordinary method.—*Nature.*

M. Pagan's device may be very effective in preventing collisions, but it must make things rather lively for the passengers.

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

By M. N. Forney.

(Copyright, 1887, by M. N. Forney.)

(Continued from page 228.)

CHAPTER XII.

THE CYLINDERS, PISTONS, GUIDE-RODS, AND CONNECTING-RODS.

Question 300. *How are the steam cylinders constructed?*

Answer. They are made of hard cast iron, and have the steam and exhaust ports and valve-seats cast with them. The harder the iron the better will the cylinders withstand the wear of the pistons and valves, but they must at the same time be made soft enough, so that after they are cast the inside can be bored out perfectly cylindrical, the ends turned off, the bolt-holes drilled, and the valve-seats planed smooth.

Fig. 177 represents a longitudinal section through the center of the cylinder and steam-chest. Fig. 178 is a plan of the same parts with the cover of the steam-chest and the valve removed. Fig. 179 is a front end view, and fig. 180 a transverse section,

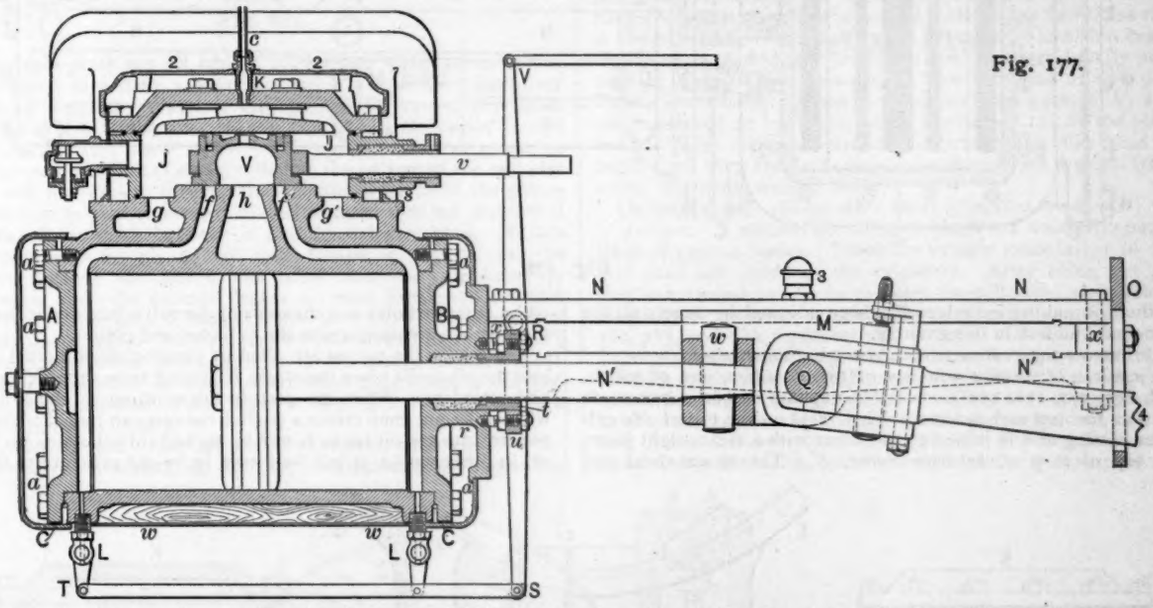


Fig. 177.

through *c d*, fig. 178, of the cylinder. Fig. 181 is a transverse section through the guide bars *N N*, fig. 178, looking backward towards the cross-head and cylinder. The same letters indicate like parts in the different views.

The cylinders of locomotives in this country are now universally placed on the outside of the wheels, as has already been described. In order to fasten them securely together and to the boiler, they are attached to what is called *bed-plates* or *bed-castings*, *D D*, figs. 179 and 180, which are placed between them. Sometimes the bed-castings are made in a separate piece, and the cylinders are then bolted to it on the outside, about at the dotted lines *l m*, fig. 179. The usual practice now is to cast one-half of the bed-casting with each cylinder, as shown in the engravings, and then bolt them together at the line *i j*, which is the center of the engine. The bed-castings are also bolted to the smoke-box by the flanges *E E*. The cylinders are bolted to the frames *F F* with bolts, *m* and *k*, figs. 179 and 180.

After the cylinders are bored out and the ends turned off, *heads*, *A* and *B*, fig. 177, are fitted with steam-tight joints to each end. These heads are fastened with bolts and nuts, *a a a*, to flanges, *C C*, fig. 178.

Question 301. *How is the steam conducted to and from the cylinders?*

Answer. Two pipes or passages are cast in each cylinder, the one, *G*, fig. 180, for admitting steam into the steam-chest, and the other, *H H'*, for exhausting it from the cylinders. The one, *G*, is called the *steam-passage*, and the other, *H H'*, the *exhaust-passage*. The steam-passage terminates at one end with a round opening, *G*, figs. 178 and 180, to which the steam-pipe *o*, fig. 90, is attached inside of the smoke-box. At the other end it divides into two branches, *G' G'*, shown by dotted

lines in fig. 178, each of which terminates in an opening, *g g'*, inside of the steam-chest. The steam is thus delivered at both ends of the chest, and can pass freely into each of the steam-ports when they are open. By making the cylinders in this way, they are exactly alike for each side of the engine, or, to use a shop phrase, there are "*no rights and lefts*," so that a cylinder casting can be used for either side of the engine. This

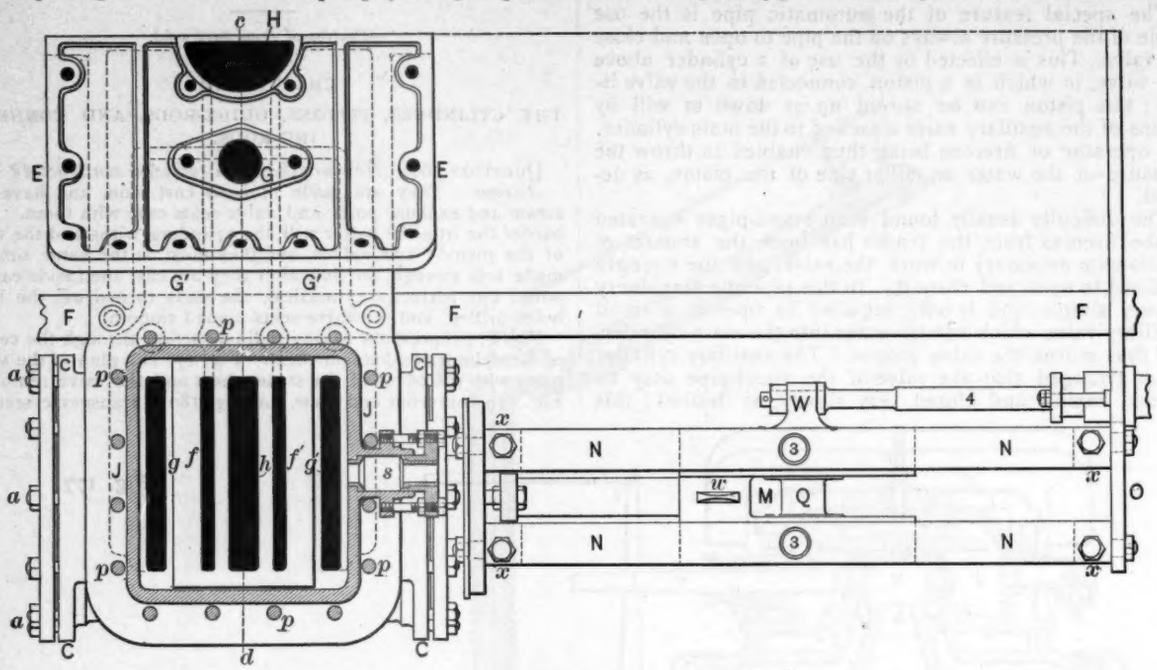


Fig. 178.

method of making cylinders has been adopted by nearly all the principal builders in this country.

QUESTION 302. *How is the steam-chest constructed?*

Answer. It usually consists of two castings, one of which, *J J*, figs. 177, 178, 179, and 180, is a square cast-iron box made open at the top and bottom. This rests on the top of the cylinder casting and is joined to the latter with a steam-tight joint. On top of it is a cast-iron cover, *K*. The steam-chest and cover are held down by bolts, *p p*, which are screwed into the cylinder casting and have nuts on top.

QUESTION 303. *How are the slide-valves made to work steam-tight on the valve-seats?*

Answer. They are first planed off smooth, and then filed and scraped until the two touch each other over the whole of their surfaces in contact. The valve-stem *v*, fig. 177, works steam-tight through a stuffing-box, *s*, on the steam-chest.

QUESTION 304. *How are the valves and pistons oiled?*

Answer. The oil is usually introduced into the steam-chest through a pipe *c*, which is connected with a cock in the cab called the *cylinder oil-cock* or "*oiler.*" From this cock the oil flows through the pipe and down upon the valve and is conducted by suitable holes and channels to the valve-face and from there through the steam-ports to the cylinder and piston.

Sometimes the valves are oiled by pouring oil or melted tallow into the oil-cocks when the steam is shut off from the steam-chests and cylinders. When the pistons are working in the cylinders without steam, they create a partial vacuum, so that if oil is then poured into the oil-cocks it will be sucked into the steam-chests, or, in other words, it will be forced in by the pressure of the air above it. A shelf 105, fig. 165, is attached to the boiler to receive an oil-can filled with oil or tallow, which is thus melted or kept in a fluid condition by the heat of the boiler.

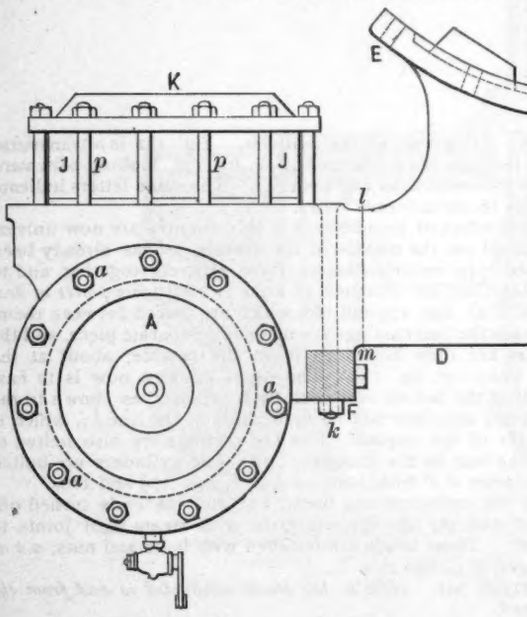


Fig. 179.

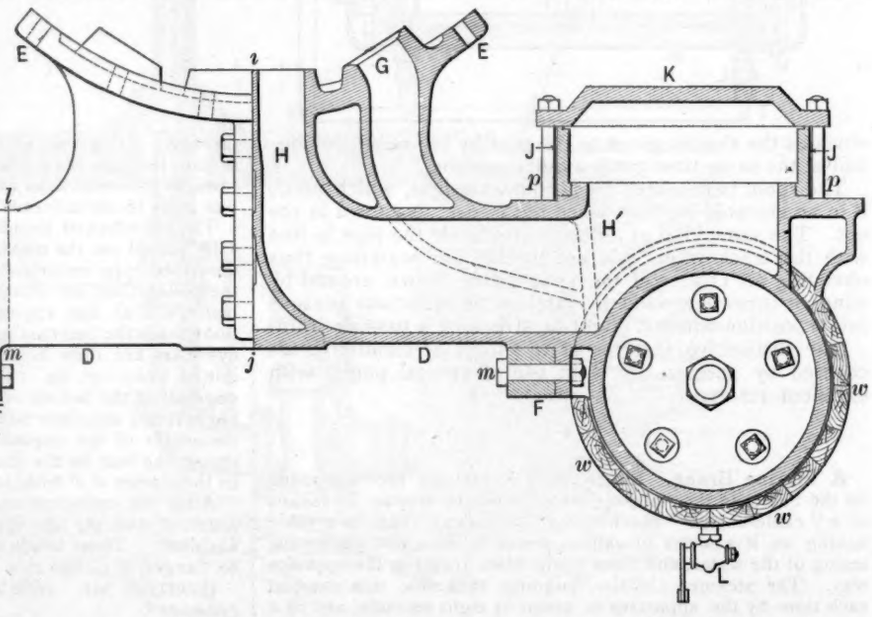


Fig. 180.

QUESTION 304. *How are the cylinders and steam-chests protected so as to prevent, as far as possible, the heat in the steam from being lost?*

Answer. The sides of the cylinders are covered with wood, *w w w*, fig. 180, called the *cylinder lagging*, and the wood is covered outside with Russia iron, which is called the *cylinder-casing*. The ends of the cylinders have light metal covers, called *cylinder-head covers*, shown in section at *a a*, fig. 177, made of cast iron, brass, or sheet metal. The steam-chest has a similar cover, 2 2, fig. 177. Sometimes coarse felt is used for lagging the cylinder and steam-chest.

QUESTION 305. *For what purpose are the cocks L L, figs.* 177, 179, *and* 180, *at each end of the cylinder, used?*

Answer. They are used to exhaust the water which collects in the cylinders. When the engine is not working the cylinders

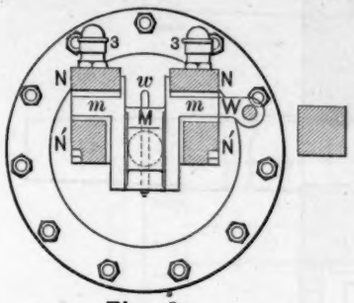


Fig. 181.

and steam-pipes are all cooled off, so that when steam is first introduced into them a great deal of it is condensed until they become warmed. Water is also frequently carried over from the boiler with the steam. When this occurs the boiler is said to *prime*, or to "*work water.*" This water and that produced by the condensation of steam collect in the bottom of the cylinder and will not escape through the exhaust-pipes until the piston moves up so near to the end of the cylinder that the water will fill the whole space between it and the cylinder-head. As has already been stated, it will then escape so slowly that the momentum of the piston and other machinery is liable to "knock out" the cylinder-heads or even break the cylinder itself. The cocks *L L*, called *cylinder-cocks*, are therefore placed in the under side of the cylinder, so that when they are open if there is any water in the cylinder it will escape through them. They are therefore always opened when the engine is starting, or at any other time when there is any indication that there is water in the cylinders.

QUESTION 306. *How are these cocks opened and closed?*

Answer. A shaft, *R*, fig. 177, which extends across the frames, has an arm, *R S*, fig. 177, at each end. These arms are connected by rods, *S T*, with the handles of the cylinder-cocks. The shaft also has a vertical arm, *R V*, the upper end of which is connected by a rod with the cab. At the end of the rod is a suitable handle by which the cocks can be either opened or closed at pleasure by the locomotive runner.

QUESTION 307. *How is the piston-rod fastened to the piston?*

Answer. It fits into a straight or tapered hole in the piston-head, in which it is fastened either with a key or by a nut on the front side of the piston.

QUESTION 308. *How are pistons constructed?*

Answer. They are made in a variety of ways. Figs. 182 and 183 represent a form of piston which has been used for many years and is still preferred by some engineers. Fig. 182 shows the front side of the piston with one-half of the follower-plate removed, and fig. 183 is a longitudinal section.

They are made of two cast-iron pieces, *B* and *C*, fig. 183, the one, *B*, called the *piston-head* or *spider*, to which the piston-rod *D* is attached. The other part, *C*, called the *follower-plate*, is bolted to the piston-head by the bolts *f f*, called *follower-bolts*.

QUESTION 309. *How are pistons made to work steam-tight in the cylinder?*

Answer. The old way of making pistons is shown, as noted above, in figs. 182 and 183. Pistons of this kind have two rings, *A A*, called *packing-rings*. These rings are turned of the same size or a little larger in diameter than the cylinder. They are then cut open at one point in their circumference so that they can be pressed apart or expanded by the springs *a a*, called *packing-springs*, on the inside of the rings. These springs are pressed out by the nuts and bolts *b b*, called *packing-bolts* and *packing-nuts*, so that when the rings wear they can be expanded so as to fill the cylinder completely. The place where the one ring is cut is placed opposite that of the opening in the other ring, or they are made to *break joints*, as it is called. This is done to prevent the steam which leaks through the opening where the one ring is cut from passing through to the other side of the piston. These rings are usually made of brass and have grooves, *c c*, fig. 183, turned in them, which are filled with what is called Babbitt's metal. This metal is used because it is less liable to scratch the cylinders than brass alone. Another ring, *l l*, made of cast iron and as wide as the two brass rings, is placed inside of the latter and is intended to furnish a bearing for the springs, and thus distribute their pressure equally on the packing rings. This iron ring is also cut open at one point. The follower-bolts, *f f*, are screwed into brass nuts, *N N*, which are contained in cavities cast in the lugs, *L L*, on the piston-head. These brass nuts are used to prevent the bolts from rusting fast, as they are liable to when screwed into the cast iron of which the piston-head is made.

QUESTION 310. *What other kinds of pistons are there?*

Answer. A number of different kinds are used with packing rings of various forms. These are usually made larger in diameter than the inside of the cylinders. After being cut apart they are compressed so as to enter the cylinders, and their own elasticity or tendency to spring apart keeps them tight. Figs. 184, 185, and 186 represent one form of this kind of packing. It consists of a main ring, *l l*, which has two grooves turned in it which receive the two rings *A A*, which, as explained, are made somewhat larger than the cylinder. They are cut apart and are held in the grooves by a flange on the piston-head on one side, and by the follower-plate on the other. The ring *l l* is not cut open, but is left solid, and the weight of the piston causes this

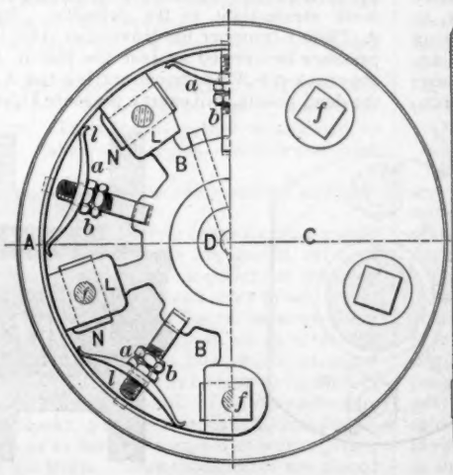


Fig. 182.

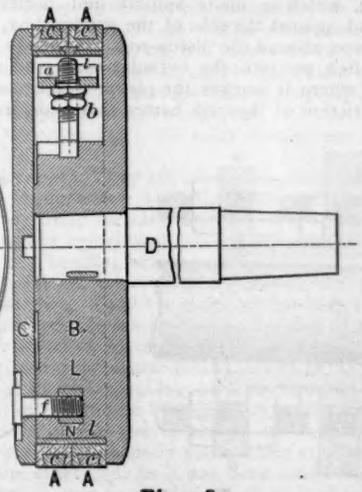


Fig. 183.

ring to bear on the bottom of the cylinder. The openings *b b*, where the rings *A A* are cut apart, are placed at the bottom of the piston, as shown in figs. 184 and 186. Fig. 186 is an inverted plan of the piston, and shows the position of the openings. As the ring *l* bears on the bottom of the cylinder it keeps the piston tight at that point, so that any steam which may leak through either of the openings *b b* could get no further than the ring *l*. The elasticity of the rings *A A* causes them to bear against the top and sides of the cylinder and in that way keep them tight; *a a* are pins to prevent the rings *A A* from turning.

In some other pistons the packing rings are cut into sections and are either pressed out by some form of springs, or steam is admitted to the grooves in which they are held so as to press

them out against the inner surface of the cylinder, and thus keep the piston tight.

QUESTION 311. *How is the piston-rod made to work steam-tight through the cylinder-head?*

Answer. By what is called a *stuffing-box*, shown at *r*, fig. 177, and on a larger scale in fig. 187. It consists of a cylindrical chamber, *r r*, which is made about 1½ in. larger in diameter than the piston-rod, which leaves a space ¾ in. wide all around

Fig. 184.

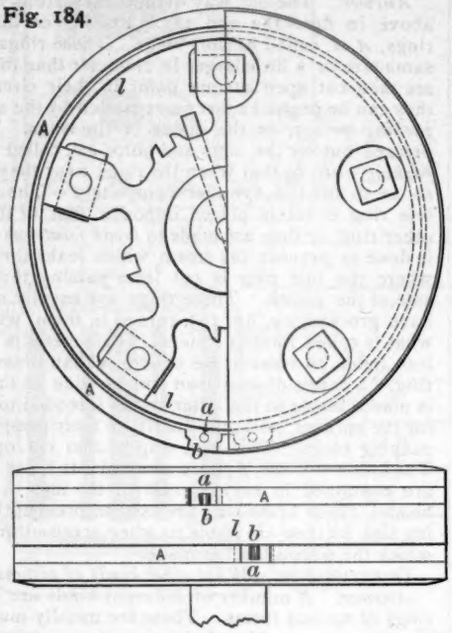


Fig. 186.

the rod. This space is filled with hemp or some other fibrous material, called *packing*, saturated with oil or melted tallow. In some cases metal packing is used. The fibrous packing is compressed by a hollow cylinder, *t t*, called a *gland*, the inside of which fits the piston-rod *P* and the outside the stuffing-box. This gland is forced into the stuffing-box by nuts, *n n*, which are screwed down on a flange, *u u*, attached to the gland. The packing is thus compressed in the stuffing-box and forced against the piston-rod, which is made smooth and perfectly round and straight, and against the side of the stuffing-box, so that no steam can escape around the piston-rod. A brass ring or "*bushing*," *b b*, is often put into the cylinder-head, and another, *c c*, in the gland where it touches the piston-rod, because brass will resist the friction of the rod better than cast iron,

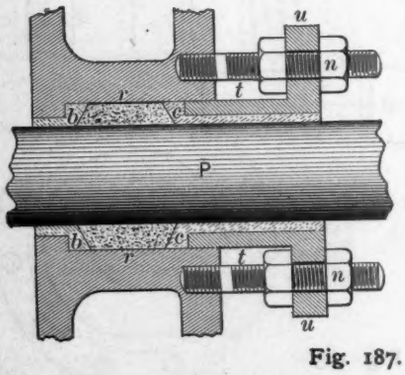


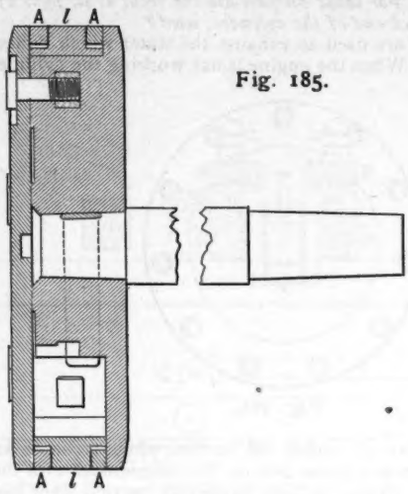
Fig. 187.

and when the "bushing" is worn out it can be removed and a new one put in its place.

QUESTION 312. *How is metal packing for piston rods and valve stems made?*

Answer. A number of different kinds of metal packing are now used. One of these kinds, made by the United States Metallic Packing Company, of Philadelphia, is illustrated by fig. 188. It consists of a cap, 1 1, which is bolted over the stuffing-box. The latter contains a number of metal rings, in which the piston-rod *B* works. These rings are made as follows: 3 3 is a solid ring made of brass, with a spherical surface on one side which bears against the cap 1 1, and a flat surface on the other side. A solid cast-iron ring, 4 4, bears against the flat surface of 3 3; 4 4 has a conical cavity on the inside which contains a number of soft metal rings, 5 6 6, which are cut into a number of pieces or sectors. A solid brass ring, 7 7, bears on these, and is pressed against them by a spiral spring, 8. The steam in the cylinder also presses on these rings and forces the soft metal packing rings into the conical cavity in ring 4, which causes them to contract and bear against the piston-rod, and thus makes them steam-tight. The spiral spring holds the rings

Fig. 185.



in place on the return stroke of the piston, when the steam in the back end of the cylinder is exhausted or when steam is shut off from the cylinders. The purpose of the spherical and flat surfaces of the ring 3 is to permit it to adjust itself to any position of the piston-rod in case it should "get out of line."

QUESTION 313. *Why is the end of the piston-rod made to work in guides?*

Answer. Because, as was explained in answer to questions 74, 75, and 76, it must move in a straight line if it and the piston work steam-tight in the cylinder. By referring back to fig. A, Plate 1 (number for November, 1887), it is obvious that if a pressure be exerted against the piston *B* and communicated to the crank-pin *N* by the connecting-rod *E*, the latter, excepting at the dead-points, will exert a pressure either upward or downward,

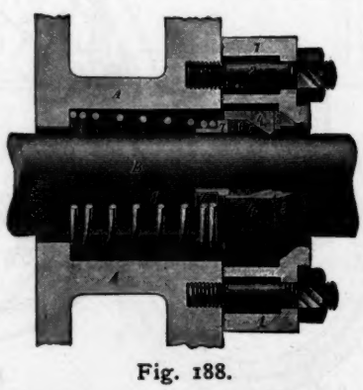


Fig. 188.

according to the direction the piston is moving. This pressure would bend the piston-rod if no provision were made to prevent it. For this reason the end of the piston-rod is attached to what is called a *cross-head*, *M*, figs. 177, 178, and 181, which works in guides, *N N*, *N' N'*, called *guide-bars*.

QUESTION 314. *What are the different forms of cross-heads and guides that are used?*

Answer. The cross-head shown in figs. 177, 178, and 181 is the one which is generally used on passenger engines. The cross-head is made of cast iron, and has slides, *m m*, fig. 181, one on each side, which work between pairs of guide-bars, *N N'*, shown in section in fig. 181. These guide-bars are planed and finished with great accuracy, so as to be straight and smooth,

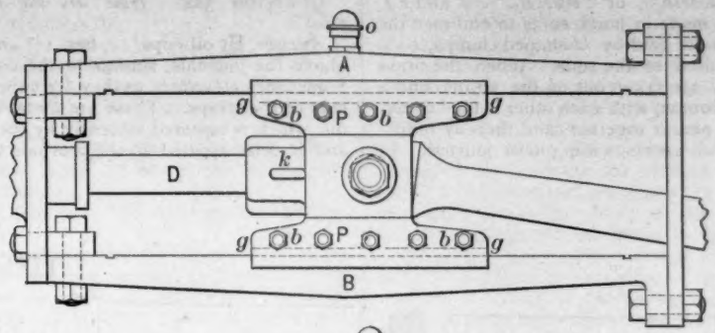


Fig. 189.

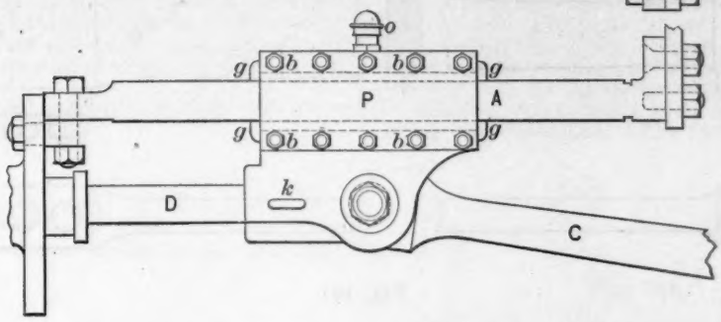


Fig. 190.

and are attached to the back cylinder-head and to a support *O*, fig. 177, called the *guide-yoke*, which is fastened to the frame at *F*, fig. 178, and is also usually attached to the boiler. The guides are set with great care, so as to be exactly parallel with the axis or center line of the cylinder, so that the cross-head will slide in exactly the same path that the piston-rod will if it moves in a straight line. If, then, the piston-rod and the connecting-rod are attached to the cross-head all the strain produced by the obliquity of the connecting-rod will be borne by the guides, thus relieving the piston-rod, and making it certain that it will move in a straight line.

Figs. 189 and 190 represent cross-heads which are used on freight engines. In fig. 189 there is a single guide-bar above and another below the cross-head. In fig. 190 there is a single guide-bar above the cross-head; sometimes two bars above the cross-head are used instead of the single bar. These forms are used when one of the driving-wheels is opposite to the guide-bars, as is the case on mogul, consolidation, and some other engines. In such cases there is not room enough to place the guide-bars on each side of the cross-head.

QUESTION 315. *How are the piston and connecting-rods attached to the cross-head?*

Answer. The end of the piston-rod fits into a tapered hole in the cross-head and is held by a key, *w*, figs. 177 and 178, and *k k*, figs. 189 and 190. The connecting-rod is attached to a pin, *Q*, figs. 177 and 178, called a *wrist-pin*, which is cast with the cross-head.

QUESTION 316. *How is the wear of the slides lessened and compensated?*

Answer. Sometimes they are made with brass wearing pieces called *gibs*, shown at *m m*, fig. 181, which are placed between the slides and the guides. These gibs can either be removed and new ones substituted when they become very much worn, or by inserting thin pieces of metal, called liners, between them and the cross-head, they will be spread apart so as to fill the space between the slides. The slides are now, however, often made without gibs, and have recesses either cast or drilled in them, which are filled with Babbitt's metal. Double guide-bars are bolted at each end to blocks, *x x*, fig. 177, called *guide-blocks*, which can be planed off so as to bring the guides nearer together when they and the slides are worn. Sometimes liners are placed between the blocks and the guides, which can be removed when it is necessary to bring the guides nearer together.

QUESTION 317. *Are the guides worn alike?*

Answer. No; when the engine is running forward the connecting-rod presses the guide upward during both the forward and the backward stroke of the piston, and in running backward the pressure of the rod is downward.

This will be understood by referring back to the series of figures from 15 to 28 (November, 1887). It will be noticed that in the backward stroke of the piston, represented by figs. 15 to 21, the strain on the connecting-rod tends to *push* the cross-head upward, and in the forward part of the stroke, figs. 22 to 28, the connecting-rod *pulls* the cross-head in the same direction. If the crank turned the opposite way, this action would be reversed and the cross-head would then be alternately pushed and pulled downward. Consequently, when the engine is running forward the under surfaces of the guide-bars and in running backward the upper surfaces will be worn most. As nearly all locomotives run forward more than backward, the under surfaces are usually worn the most.

QUESTION 318. *How are the slides oiled?*

Answer. Oil cups, 3 3, are attached either to the top guides, as shown in figs. 177, 178, and 189, or to the cross-head, as in fig. 190. These cups usually have a reservoir to hold a supply of oil, and are so constructed that it will be gradually fed on the slides, which are thus constantly and regularly lubricated. Their construction will be explained in another chapter.

QUESTION 319. *How are the pumps worked by the pistons?*

Answer. The pump-plunger, 4, is attached to a projection, *W*, figs. 178 and 181, called the *pump-lug*, cast on one of the slides of the cross-head. The plunger thus receives a reciprocating motion from the piston.

QUESTION 320. *What are the connecting-rods for?*

Answer. The rods which connect the cross-heads to the main crank-pins—which are called *main connecting-rods*—communicate the pressure on the piston to the main crank-pin. The rods which connect or couple the crank-pins on adjoining driving-wheels together are called *coupling-rods*,* and they cause the wheels to revolve together.

QUESTION 321. *To what strains are the connecting-rods subjected?*

Answer. They are alternately subjected to a strain of tension and compression by the pressure of the steam on the pistons during their forward and backward strokes. They must also resist the centrifugal force due to their revolution, which produces a bending action on the rods.

QUESTION 322. *How are the connecting-rods made?*

Answer. They are made of flat bars of wrought iron. Fig. 191 represents a side view and a plan of a main connecting-rod. It is attached to the wrist-pin at *A* and to the crank-pin at *B*. Fig. 192 represents similar views of a coupling-rod. To save room in the engraving each of these rods is represented with a part of the middle broken away, and a transverse section of the middle of the rod is shown between the broken ends. The main rods are usually made wider at *G*, next the crank-pin, than at the other end, as it has been found that they are most liable to break next to the *big end B*, as it is called, than at any other place. The coupling-rods are now made either straight or somewhat wider in the center. To give them greater strength without increasing their weight too much, the sections of such rods are often made "*fluted*," as it is called—that is, of the form of the letter I.

QUESTION 323. *How are these rods prevented from getting loose on the pins from the wear of the latter in the inside of the holes of the rods?*

Answer. By a stub-end or strap-end similar to that described in answer to question 77. The ends of the rods are provided

* They are also often called *side* or *parallel-rods*, but the term *coupling-rods* is considered the best.

with what are called *brass-bearings*, or "*brasses*," *c d* and *e f*, fig. 191. These brasses are made in pairs, so as to embrace the pins from each side. They are held by U-shaped clamps, *s s s*, called *straps*, which are bolted to the rods. When the brass bearings become worn, they are taken out of the straps, and a portion of their surfaces of contact with each other is filed away, thus allowing them to come nearer together, and thereby reducing the size of the hole which receives the pin or journal. In order to prevent their being loose in the straps, tapered or wedge-shaped *keys*, *k k*, are fitted in the straps and rods. By driving down these keys the straps are drawn against the brass bearings and they are forced together, thus reducing the size of the hole for the journal, and making the rods fit tightly on the pins. A hard steel plate, *p*, fig. 191, is sometimes interposed between the keys and the brasses to prevent the key from indenting the surface of the soft brass. As the keys are very liable to get loose and fall out, they are held either by screws and nuts, *x x*, as shown on the left-hand side of the engraving, or, as shown at the other end of the rod, by a *set-screw*, *r*, on the side of the rod. The ends of coupling-rods sometimes have stub-ends, as shown in fig. 192, but are often made without, and with simple *bushings* or brass rings, *b b*, driven into holes in the ends, as shown in fig. 193. When these bushings become worn they are taken out and new ones are put in their places.

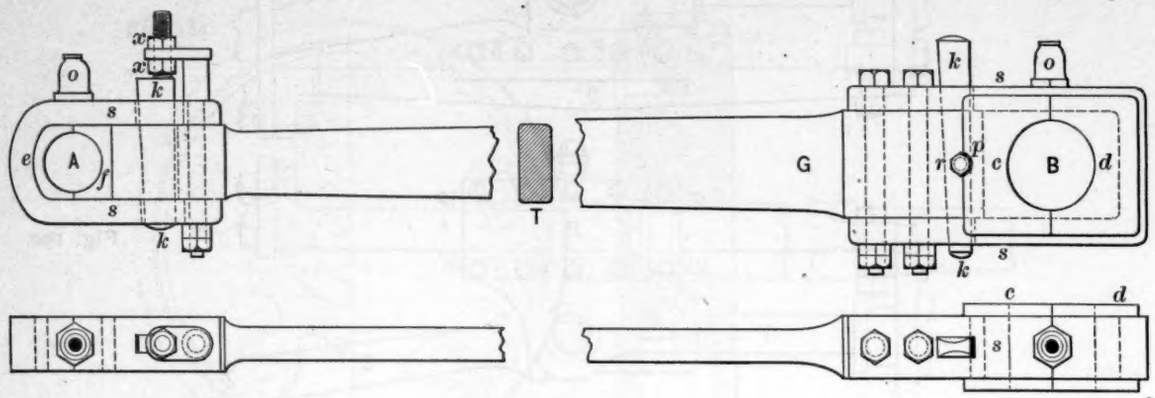


Fig. 191.

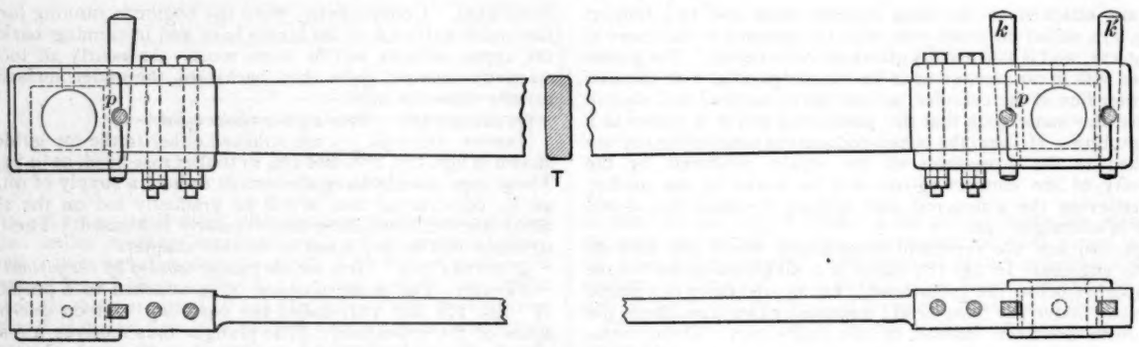


Fig. 192.

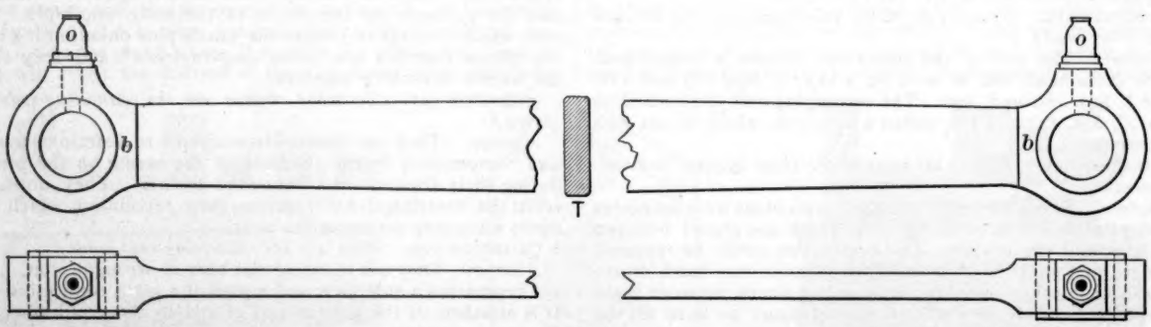


Fig. 193.

QUESTION 324. *How are the journals of the crank-pins oiled?*

Answer. By oil-cups, *o o*, figs. 191 and 193, attached to the straps above the journals, similar to the cups used on the *guide-rods*. Sometimes *oil-cellars*, as they are called, are attached to the under side of the straps. These are metal boxes, which are filled with oil, which is agitated violently by the rapid motion of the rods, and is thus applied to the journals through holes drilled in the straps. In order to confine the oil and prevent its leaking out around the journals of the coupling-rods, the brasses are sometimes made so as to enclose the outside end of the crank-pin, which thus not only keeps the oil in, but excludes the dust. The brasses are usually lined with Babbitt's or some other kind of soft metal, which is thought to be less liable to heat from the friction of the journals.

QUESTION 325. *What is meant by the term lost motion?*

Answer. It is used to designate the wear of machinery, which causes a loss of motion in some of the parts. Thus if the bearings of the main connecting-rods are worn, the piston must move a distance equal to the wear at each end of the stroke before it moves the crank-pin. Lost motion might therefore be called the looseness of the parts. When we speak of *taking up* the lost motion, we mean making parts which were loose fit tightly.

CHAPTER XIII.

THE VALVE-GEAR.

QUESTION 326. *What is meant by the valve-gear of a locomotive?*

Answer. By the valve-gear is meant the arrangement of eccentrics, rods, links, rockers, etc., by which the valves are moved and their motion regulated.

QUESTION 327. *What is required of the valve-gear in working a locomotive?*

Answer. It must be so arranged that the locomotive can be run either backward or forward, and so that the motion of the wheels can be reversed quickly and with certainty. It should enable the runner to employ the greatest power of the engine by admitting steam into the cylinders during the whole or nearly the whole of the stroke of the pistons, or, when less power is required, to use the steam more economically by working it expansively.

QUESTION 328. *How is the valve-gear constructed so as to run the engine either backward or forward?*

Answer. As already explained, in answer to question 287, two eccentrics are provided for each cylinder. These are set so that one of each pair will run the locomotive in one direction, and the other two the reverse way.

QUESTION 329. *How must the eccentrics for each cylinder be set in order that the one may run the engine forward and the other backward?*

Answer. This can be best explained by reference to fig. 194, in which the piston, *P*, is represented at the beginning of the backward stroke, and the valve *V* has the requisite lead, and is just about to open the front steam-port. It is obvious that, in order to complete the backward stroke of the piston, the front port, *c*, must be opened to admit steam into the front end of the cylinder, and therefore the valve must be moved in the direction indicated by the dart *a*. To do this, the upper arm of the rocker *R* must move in the same direction indicated by the dart *a'* and the lower arm must be moved the reverse way, as indicated by the dart *b*. If the crank is intended to move in the direction indicated by the dart *N*, then the center of the eccentric *J* must be above the center of the shaft or axle, to move the lower end of the rocker in the direction indicated by the dart *b*. Supposing, however, it was intended to move the crank the reverse direction, as shown by the dart *N* in fig. 195; it is evident in that case that the valve must be moved in the same direction as before, to open the front steam-port *c*, and thus admit steam to force the piston back. But if the crank turns in the direction shown by the dart *N*, fig. 195, then the center of the eccentric *K* must be placed *below* the center of the axle to move the lower rocker arm in the direction of the dart *b*, and the valve in that indicated by *a*. It will thus be seen that the center of the eccentric for running forward and of that of the one for running backward must be placed, the one above and the other below the center of the axle at the beginning of the stroke of the piston, as shown in fig. 101.

QUESTION 330. *Why is it that the centers of the eccentrics are not placed opposite to each other on the axle?*

Answer. Because before the beginning of the stroke of the piston it is necessary to move the valve from its middle position a distance equal to the lap before the steam-port begins to open. If we had a valve without any lap, the centers of the eccentrics could be placed at right angles, or, as mechanics say, "square" with the crank, and exactly opposite to each other, because such a valve would begin to take steam as soon as it moved from the middle of the valve-face. But if we have a valve like that shown in fig. 49, it is plain that before it will admit or *take* steam, as it is called, in either of the steam-ports, it must be moved from the center of the valve-face, or its *middle position*, a distance equal to the lap, *L*. For this reason, therefore, the eccentric, instead of being placed at *half-throw*,* as it is called, must be so far ahead of the middle position as to have moved the valve a distance equal to the lap, and if any lead is given to the valve, equal to the lap and lead together. In figs. 194, 195, and 196, *f g* is a vertical line at right angles to the crank at the beginning of the stroke. It will be seen that the center of each of the eccentrics is set far enough ahead of this line to give the valve the required lead. When the piston reaches the back end of the cylinder, the two eccentrics will occupy the position shown in fig. 196, in which position the lower one, *J*, would move the valve so as to turn the crank in the direction of the dart *N*, and the upper one, *K*, will turn it in the reverse direction. It will be seen that in this position both of the eccentrics are again ahead of their half-throw, when the piston is at that end of its stroke.

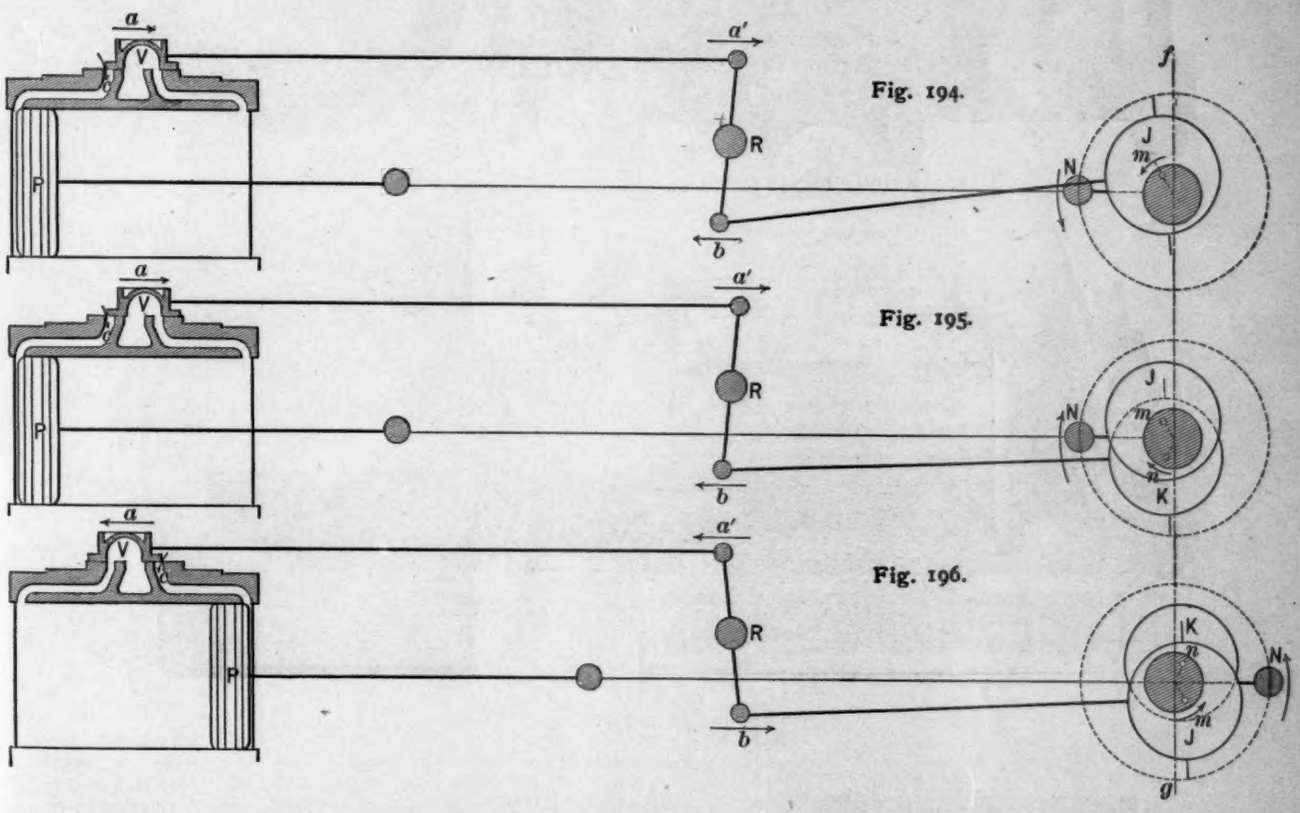


Fig. 194.

Fig. 195.

Fig. 196.

(TO BE CONTINUED.)

* This would be at right angles to the crank when it is at a dead point, and the piston is at the end of the stroke.

Manufactures.

The Baker Dust-Guard.

THE accompanying illustrations represent a dust-guard intended to prevent the entrance of dust and sand into car journal boxes; and also to prevent the leakage of oil from them. This system, it is claimed, avoids the defects of some others which have been previously devised, and has proved in service very effective in reducing the wear of journals and bearings, and also in saving the amount of lubricating oil used. The accompanying illustrations, figs. 1 and 2, show the device as applied to a M. C. B. standard axle-box, with the addition of a lubricating device and dust-tight lid in connection with the dust-guard itself.

The system adopted in this arrangement is that of a cushioned and spring-actuated washer revolving with the axle and wheel and bearing on the back of the axle-box, which is made smooth to receive it. Around that part known as the dust collar of the axle of any ordinary construction is a metallic sleeve formed with a key-way, or longitudinal groove, on its inner side, which fits over a key in the axle, so that while the sleeve is keyed to the axle and revolves with it, it is free to move longitudinally. The key is T-shaped and is inserted in a $\frac{5}{8}$-in. hole drilled $\frac{1}{2}$ in. deep in the axle at the proper place. A coiled spring, bearing at one end against the flange and at the other against the face of the hub of the car-wheel, is placed on the outside of the sleeve. It has a flange at the end next to the axle-box. Upon the face of the flange next to the axle-box is riveted a vulcanized asbestos washer, which bears against the axle-box, making a dust-tight joint. The spring is made just strong enough to hold the flange and washer up against the axle-box without undue pressure or friction, and to permit the usual amount of end-play of the journal without uncovering the opening in the box. Experience has shown that the wear upon the washers is extremely light.

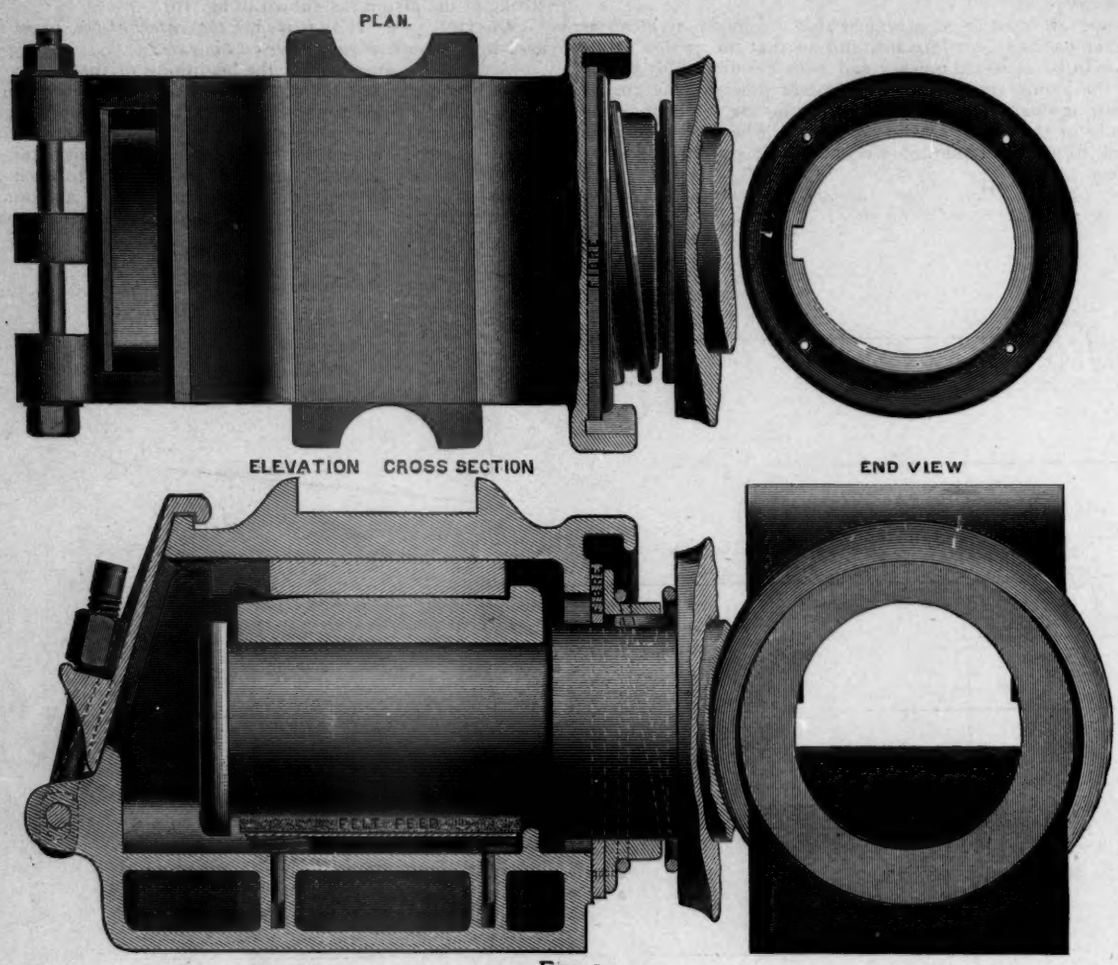


Fig. 1.

THE BAKER DUST-GUARD.

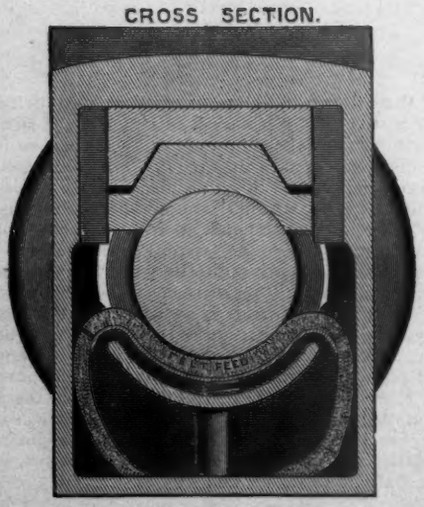


Fig. 2.

This dust-guard can be applied to any pattern of axles or axle-boxes in use, the only change required being that the back of the box should be left smooth by leaving off the dust-guard housing ordinarily cast on the box. The use of the dust-guard will not prevent interchange with the present pattern of boxes should occasion for it arise.

The inventor and manufacturer, Mr. W. S. G. Baker, of Baltimore, claims that the use of his dust-guards reduces considerably both the quantity of oil used and the wear of the bearings. Their cost is very small both in itself and in comparison with the saving effected by their use. They have been in service long enough to fully test their merits.

The Hix Car-Coupler.

It was predicted a month or two ago in these pages that the adoption by the Master Car-Builders' Association of standard contour lines for automatic couplers would result in a new crop of inventions "that will couple to and with" couplers having these contour lines. An invention of this kind is shown by the engravings herewith.

One of the difficulties with the Master Car-Builders' type of coupler is that the hook, *A*, must resist the concussion when a car equipped with such a coupler comes in contact with one having the old-fashioned draw-bar. The consequence is that the hooks are sometimes broken by the concussions. The inventor of the coupler illustrated has tried to overcome this difficulty by attaching the hook *A* to the draw-head by a slot *C*, in which the pin *B* can slide; consequently, when an ordinary draw-bar comes in contact with the hook it is simply pushed back until it bears against the draw-head, thus relieving the pin *B* of all strain on it. *G* is a latch connected to the draw-head by a pin *E* and slot *F*, fig. 2. When the hook is pushed back in buffing it moves the latch *G* upward on the bolt *E*, so that when the pressure on the latch is relieved its weight causes it to fall downward, and thus pushes out the hook into the position shown in the engraving. Ordinary draw-bars are coupled by a link to a pin *h*, which is in the head instead of being attached to the hook, as in the Janney and some other forms of couplers. The knuckle-joint of the hook is thus relieved of all strain of pulling and buffing when coupled to ordinary draw-bars.

This coupler is the invention of O. P. Hix, of Rockland, Me.

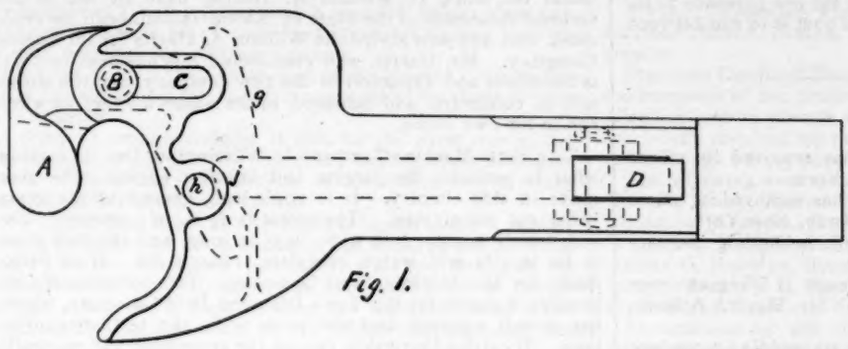


Fig. 1.

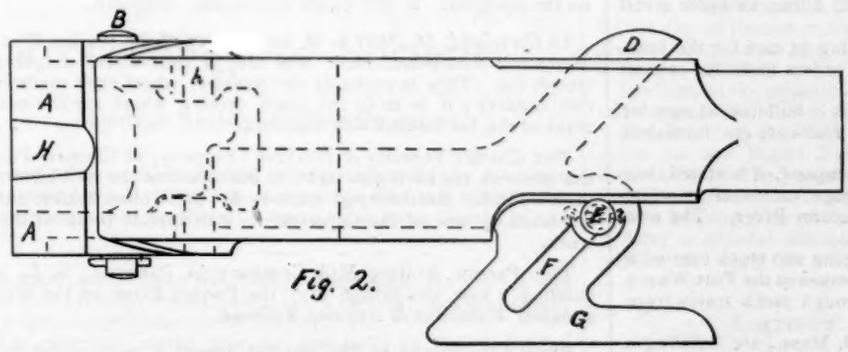


Fig. 2.

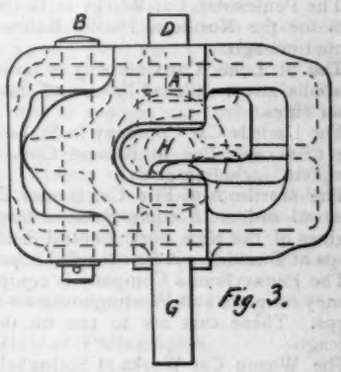


Fig. 3.

THE HIX CAR-COUPLER.

Air Compressors.

The use of compressed air in operating rock drills and other machinery in tunneling and other underground work has become so general that the air compressor is recognized as an essential part of the contractor's plant. It is equally so in putting in the substructure of bridges, the employment of the pneumatic process being almost universal wherever it can be used.

In the Stampede Pass Tunnel on the Northern Pacific Railroad, the completion of which is noted elsewhere, much of the work was done by a Clayton air compressor operated by water power. Compressors of the same make were used in sinking the caissons for the piers of the Bismarck bridge on the Northern Pacific road, and have been employed in many other places.

The special advantages claimed for these compressors are the close regulation of the speed by which uniformity of pressure and steadiness of action are secured, and the arrangements by which the air cylinders are kept cool.

These compressors are not only used for tunnel and mining work, bridge foundations and similar work, but also in wrecking and other submarine operations, to furnish air to divers. In this class of work their steadiness and uniform action are especially valuable.

Electric Street Cars.

The Sprague motor is now on trial on the street railroad line in Davenport, Ia. The cars of that line are already lighted on the Sprague system.

A street car operated by storage batteries on the Julien system is now on trial on the North Baltimore Passenger Railroad. There are many heavy grades on this line which it is stated the car works over without difficulty.

During June the upper section of the Fourth Avenue line in New York, running from the stables on 86th Street to the Mott Haven station at 138th Street, will be operated entirely by electric cars. A number of these cars are completed and nearly ready to be put in use. The Julien storage batteries are used, and the car is similar to that which has been running on the Fourth Avenue road for some time.

Indurated fiber, which has recently been introduced for many purposes, has found a new use; it is now employed in the manufacture of cells for storage batteries and electrical accumulations. The cells for the new electric cars on the Fourth Avenue line are made of this material, and it has also been applied for the manufacture of pipes or conduits for underground wires.

Track Washers.

A substantial improvement has recently been made in the manufacture of fiber track washers by the Vulcanized Fiber Company. This consists in the use, in place of the iron casing in which the fiber has heretofore been held, of a casing or base of steel, stamped out of thin steel plate. This is not only stronger, but is more durable, and in every respect better than the iron washer, and it is also lighter. The use of these washers for track-bolts is approved by long use and practical service in the track.

Marine Engineering.

THE steel ferry-boat *Erastus Wiman* was recently launched from the yard of the Columbian Iron Works in Baltimore. The boat is of the following dimensions: Length between perpendiculars, 225 ft.; length over all, 236 ft.; breadth of beam, moulded, 36 ft.; breadth over guards, 64 ft.; depth of hull, 14 ft.; draft of water, including keel, 7 ft. 10 in.; draft of water from base line, 7 ft.; estimated displacement, 1,100 tons. The hull is of steel of 60,000 lbs. ultimate tensile strength per square inch of section, with a ductility of not less than 23 per cent. and an elastic limit of 35,000 lbs. per square inch of section. The steel throughout is of the best quality obtainable for the purpose.

The *Wiman* will have one inclined compound engine of about 1,200 indicated H.P. The cylinders are placed side by side and act upon a shaft having two cranks at right angles with each other. They have separate sets of eccentrics for running each way. The valve of the high-pressure cylinder is a piston valve, while that of the low-pressure cylinder is the plain side valve. The high-pressure cylinder is 39 in., and the low-pressure 70 in. diameter, both having 60-in. stroke. The boat is to run between New York and Staten Island.

Cars.

THE Lappin Brake Shoe Company has removed its offices from No. 239 to No. 45 Broadway, New York.

The Consolidated Coupling Company has removed its offices from No. 173 Broadway to No. 45 Broadway, New York.

The Michigan Car Company in Detroit is building 200 cars for the Wheeling & Lake Erie Railroad.

The Wells & French Company in Chicago is filling an order for 500 box cars for the Minneapolis, Sault Ste. Marie & Atlantic road.

The Peninsular Car Works in Detroit are building 1,000 box cars for the Northern Pacific Railroad, filling an order given some time ago.

The St. Louis Car Company is building 35 cars for the Indianapolis street railroad lines, and has orders to fill for several other cities.

The Laclede Car Company in St. Louis is building 60 cars for the new cable line in Kansas City. The cars are furnished complete, including grips.

The Martin Anti-Fire Car Heater Company, it is stated, has received orders to equip 25 more baggage cars and 20 more engines of the New York Central & Hudson River. The new shops at Dunkirk will be occupied soon.

The Pennsylvania Company is equipping 200 stock cars with Janney couplers and Westinghouse air brakes at the Fort Wayne shops. These cars are to run on through stock trains from Chicago.

The Wason Car Works at Springfield, Mass., are building a palace car for the use of Dom Luis I., King of Portugal. It is to cost about $18,000, and to be of the best materials. The outside of the car will be highly finished, and the color will probably be white; the interior wood work will be of mahogany of two or three varieties, and the wood will be handsomely carved. The car will be divided like the ordinary buffet palace car used in this country, excepting that at one end of the drawing-room, a tier of berths will be put in, which will not mar the beauty of the interior when not in use, and which may be divided off when required so that a good-sized state-room will be secured.

Manufacturing Notes.

THE Rogers Locomotive Works in Paterson, N. J., recently delivered four Mogul freight engines to the Georgia Pacific Railroad.

THE Baldwin Locomotive Works in Philadelphia recently delivered 20 consolidation freight engines to the East Tennessee, Virginia & Georgia Railroad, and have received orders for 15 more consolidation and 10 passenger engines for the same road.

THE Boston Heating Company recently purchased 45 Curtis pressure regulators from ¼ in. to 3 in. in size. The larger ones are used to control the pressure on the pumps at the central station; the small ones to reduce the 400 lbs. pressure on the street mains to from 5 to 80 lbs. as required for heating and power purposes.

THE Johnson Steel Street Rail Company has just completed an entirely new plant at Johnstown, Pa., which was successfully put in motion for the first time on May 7. The plant embraces a two-high 26-in. roll train and five heating furnaces, of the Gadsden regenerative type, each with 15-ft. beds. Bessemer blooms, purchased in the open market, will be rolled into any form of street rails that may be desired. The works are supplied with a powerful engine, traveling cranes, and all the other appliances of a first-class rolling mill. The total length of the building covering the mill is 450 ft., all fire-proof. The capacity of the works is from 100,000 to 150,000 tons per annum.

THE National Tube Works Company now has eight large building furnaces running in its works at McKeesport, Pa., making the output over 600 tons per day.

THE following changes have been made in the officers of the Safety Car Heating & Lighting Company, New York: President, Henry R. Towne; Vice-President, James C. Bayles; Secretary and Treasurer, J. J. Slocum. F. M. Wilder has resigned as General Manager, and his duties have been assumed by the Vice-President.

THE Harris-Corliss Engine Works, heretofore conducted under the name of William A. Harris, have, by act of the General Assembly of the State of Rhode Island, been incorporated and are now styled the William A. Harris Steam Engine Company. Mr. Harris, who established this business in 1864, is President and Treasurer of the new company, and the works will be conducted and managed in the same manner as when run in his own name.

THE Betts Machine Company in Wilmington, Del., is making what is probably the largest and heaviest engine lathe ever made in this country. It is triple back geared, all the gears being cut out of steel. The screw is 4½ in. in diameter. The bed, which is some 8 ft. wide, is 35 ft. long, and the face-plate is 66 in. It will weigh, complete, 120,000 lbs. It is being made for the Midvale Steel Company. This company is also erecting a planer for the Penn Diamond Drill Company, which has an 8-ft. opening, and will plane 25 ft., the bed being 40 ft. long. It carries four tools, two on the cross-head and one each on the uprights. It will weigh 90,000 lbs., complete.

IN Cleveland, O., May 8, in the foundry of the Walker Manufacturing Company, there was cast a gear-wheel weighing 50,000 lbs. This is probably the heaviest wheel ever made in this country; it is to be the main driving wheel for the new plant of the St. Louis Cable Railroad.

THE Chester Foundry & Machine Company, of Chester, Pa., has secured the exclusive right to manufacture the well-known three-cylinder Brotherhood engines for the United States, and has fitted up one of the departments with special tools for this work.

THE Passaic Rolling Mill Company in Paterson, N. J., is building a new iron bridge over the Peedee River on the Wilmington, Columbia & Augusta Railroad.

RIEHLE BROTHERS, in Philadelphia, report a more active demand than for some time past. Orders have recently been received for two 30-ton platform scales for Cramp & Sons' shipyards, and four for the Phœnix Iron Company, besides a number of heavy rolling-mill, furnace, track, and mine scales. They have also orders for a 5,000-lbs. testing machine for the Edison Machine Works at Schenectady, N. Y., and for other testing machines for different parties, besides orders for other machinery.

THE Southern Pacific Company is building some large additions to the shops at Sacramento, Cal. These include additions 150 by 90 ft. to the boiler shops; 100 by 112 ft. to the machine shop; 90 by 92 ft. to the car shop; 85 by 180 ft. to the paint shop; a two-story shop for car work, 75 by 150 ft. in size, and an oil house 50 by 100 ft. All the shops are to be fitted up with electric lights.

THE Keystone Bridge Company in Pittsburgh has the contract for 10 iron spans of 150 ft. each over the Sandusky River at Fremont, O., on the Lake Erie & Western road.

THE Rhode Island Locomotive Works in Providence have recently received a number of orders for locomotives, chiefly from Western and Southern roads. These orders include 10 consolidation engines for the Louisville & Nashville road; three 10-wheel engines for the Southern Pacific; several 10-wheel engines for the Cincinnati, Milwaukee & St. Paul; five consolidation freight engines for the Seattle, Lake Shore & Eastern road; three Mogul freight engines and three Forney engines for the Minneapolis, St. Paul & Atlantic; several switching engines for the Cincinnati, New Orleans & Texas Pacific; and a Forney engine to go to Bessemer, Ala., for the De Bardaleben Coal & Iron Company.

A New Car Spring.

FROM the time when railroad cars first came into use there has been a continued effort to secure some method by which the shocks resulting from the rapid motion and the inequalities of the track can be taken up, and an easy-riding car provided. Of course the method employed from the first has been to interpose springs of some kind between the running gear—the wheels and axles which bear directly on the track—and the body of the car. The improvements made heretofore have been, not in the general principle, but in the construction and arrangement of the springs. A great variety of these have been devised and put into use with more or less success.

The last candidate for the favor of the railroad public is the Chase combination spring. This spring is a combination of a double elliptic spring having a coiled spring placed across the center, and held by bolts passing through the ends of the elliptic. In this way the supporting power of the coiled spring is brought into use gradually, as the pressure on the entire spring increases, and the resistance of the spring adjusts itself, as it were, to the demands upon it.

It is claimed for this spring that it is much lighter than any other now in use, a set of passenger springs weighing over 30 per cent. less than the ordinary spring.

A second claim is that, on account of the support given to the end of the elliptic by the spiral, the danger of breakage is very much lessened.

A third advantage claimed is that, for the same reason, the motion of the spring is much easier and more gradual, and there is none of the quick, jerky motion, or the sudden shocks sometimes felt with the ordinary spring.

It is stated that where this spring was in use under a passenger car, no difference could be felt in the riding of the car when empty or when filled with passengers. As to durability, the most extended test yet made has been with a set of freight springs, which have been running for six years (and which weigh much less than a set of the ordinary springs), and are still in use.

Proceedings of Societies.

American Society of Civil Engineers.

APRIL 18, the subject was the Manufacture of Brick. A written discussion from Mr. Parrington was read, and the subject was verbally discussed by Messrs. Church, Cartright, Tomkins, and Fteley.

A REGULAR meeting was held in New York, May 2. It was announced that Sullivan Haslett, late a member, had bequeathed his engineering library to the Society.

The Secretary stated that the last week in June had been selected as the date of the annual convention, and that the excursion would be over the Michigan Central Railroad, from Buffalo to Milwaukee.

Members intending to present papers at this meeting are urgently requested by the Committee to prepare them early enough to enable advance copies to be printed and distributed among the members for preparation of discussions.

The Secretary read a rejoinder from John W. Hill to Mr. Howell's discussion of the former's recent paper on Test of an Edison Incandescent Electric-Lighting Plant, and extracts from a communication by Joseph Nimmo, Jr., on Fertilizing Material of New York and Brooklyn in its Relation to Transportation.

The following candidates were declared elected :

Members : Kenneth Allen, Kansas City, Mo.; Latham Anderson, Cincinnati, O.; Thomas Aspinwall, Boston, Mass.; Robert Bassel, Washington, D. C.; Harry Dean Bush, Montreal, Can.; Clarence Allen Carpenter, Chillicothe, Mo.; George Edwin Evans, Helena, Mont.; Francis Davis Fisher, New York City; Arthur Hodges, Johnstown, Pa.; George Washington Howell, Morristown, N. J.; Everett Wilson Lewis, Belmont, Wash. T.; Emile Low, Cedar Bluff, Va.; Harry Irving Miller, Richmond, Ind.; Arthur Lorenzo Mills, Toledo, O.; Edmund Trowbridge Dana Myers, Richmond, Va.; Philip M. Price, West Point, N. Y.; Beverley Strother Randolph, Frostburg, Md.; Thomas Pearman Shanks, Louisville, Ky.; George Morris Tompson, Boston, Mass.; Thomas Delano Whistler, New York City.

Associate : James Breckenridge Speed, Louisville, Ky.

Juniors : James Hillhouse Fuertes, Wichita, Kan.; William Gray, Tarrytown, N. Y.; Horace Joseph Howet, Elmira, N. Y.; Edmund Trowbridge Dana Myers, Jr., Richmond, Va.; John Edwin Ostrander, Macedon, N. Y.; Charles Bradley Rowland, Greenpoint, N. Y.; Eugene Raymond Smith, Islip, N. Y.; William Holland Stair, Fort Riley, Kan.; George Atwater Tibbals, Brooklyn, N. Y.; Samuel Gaylord Tibbals, Brooklyn, N. Y.; Herbert Waldo York, New York City.

A REGULAR meeting was held at the Society's house in New York, May 16. The death of Henry F. Welling, a member, was announced, and a committee was appointed to prepare the usual memoir.

James B. Francis, Past President of the Society, read a paper on High Walls or Dams to Resist the Pressure of Water, in which he investigated the conditions of stability of a dam under differing circumstances. The paper was discussed by a number of members present, and further discussion will be had at the next meeting at the Annual Convention. Mr. Francis's high standing as hydraulic engineer gives his paper special importance.

Boston Society of Civil Engineers.

A REGULAR meeting was held at the rooms, Boston & Albany Railroad Station, Boston, April 18 ; 43 members and 14 visitors present.

President Desmond Fitzgerald, on assuming the chair, thanked the members of the Society for the honor conferred on him in selecting him to preside over the Society for the coming year, and briefly sketched the programme which had been laid out for the meetings for the ensuing year.

The following were elected to membership : Fred. H. Barnes, Newton, Mass.; Nathan S. Brock, Lowell, Mass. ; William H. Chapman, Newport, R. I.; Louis Cutter, Winchester, Mass.; William C. Hall, South Framingham, Mass.; Frank L. Locke, Arthur G. Robbins, Boston, Mass.; George E. Whitney, Cambridge, Mass.; J. L. Woodfall, Chelsea, Mass.; E. E. Young, Hyde Park, Mass.

Committees for the ensuing year were announced by the Secretary and an amendment to the by-laws considered.

Mr. L. Frederick Rice, Chairman of the commission appointed by the city of Boston to test meters, then read a paper entitled, Method and Apparatus Used in the Recent Test of Water Meters at Boston.

Portions of the apparatus used at the test were exhibited and fully explained.

Mr. Edmund B. Weston, of Providence, followed with a paper on the Water Meter System of Providence. He described the method used in that city in testing meters before they were allowed to be used, and gave very full statistics as to cost of keeping the various kinds of meters in repair.

After a general discussion of the two papers, the Society adjourned.

Engineers' Club of Philadelphia.

AT the regular meeting at the Club's House in Philadelphia, April 21, the Secretary announced the gift to the Club, by Mr. John S. Naylor, Member, of *Van Nostrand's Engineering Magazine*, 1869 to 1886, both inclusive, bound in half morocco. A vote of thanks was returned to Mr. Naylor for this handsome and valuable addition to the Library.

Mr. L. F. Rondinella presented a series of Steam Formulæ for the *Reference Book*.

Mr. William Sellers, a paper upon the Manufacture of Eye Bars for Pin Connected Structures, illustrated by full-size test specimen, etc.

Mr. John L. Gill, Jr., discussed the desirability of Expanding in, and of Beading over, Boiler Tubes, and raised the point as to whether beading over was not, in some cases, unnecessary, or even injurious.

The President announced the following as the Committee to Recommend a Practical Method of Testing Cements, the appointment of which was authorized at the meeting of March 17 : Arthur Marichal, Chairman, Herbert Bamber, Professor L. M. Haupt, Rudolph Hering, and John C. Trautwine, Jr.

AT the regular meeting in Philadelphia, May 5, the Secretary presented for Mr. Oscar Sanne an illustrated description of a Rolling Bridge for Docks.

Mr. Robert A. Cummings presented, for the *Reference Book*, a Table of Equality of Curves at Different Scales, by means of which a set of curve patterns cut for a certain scale can be used for other scales.

Mr. M. R. Mucklé, Jr., described a general and detailed arrangement for a system of Underground Conduits for Electrical Conductors, with numerous illustrations.

Mr. Henry G. Morris presented a number of specimens of Mitis Metal Castings, and an illustrated description of the furnace used in their manufacture.

Cincinnati Association of the American Society of Civil Engineers.

A MEETING was held in Cincinnati, April 17, at which there were present a number of members of the American Society of Civil Engineers residing in Cincinnati and vicinity. It was decided to organize an Association for the purpose of discussing questions of interest relating to the American Society, and to bring together such members as reside in the city or visit it frequently. The name of the organization will be the Cincinnati Association of the American Society of Civil Engineers, and members of all classes are eligible to admission. Colonel William E. Merrill was elected President, and G. B. Nicholson, Secretary.

Engineers' Club of St. Louis.

AT the regular meeting in St. Louis, April 18, John H. Mueller and C. W. Stagl were elected members. The Club then proceeded to consider a communication from the Council of Engineering Societies on National Public Works. After discussion the subject was referred to a committee of three to report in May. F. E. Nipher, S. B. Russel, and A. W. Hubbard were appointed the committee.

Mr. S. Bent Russel then read a paper on Thickness of Water Pipes, with some Experiments on Ram, which was illustrated by a number of charts and tables showing the results, the instruments made, and the formula deduced from them. The paper was generally discussed.

AT the regular meeting of May 2, Professor A. E. Phillips was elected a member. The Librarian reported the completion of a catalogue of the books and pamphlets owned by the Club. A communication requesting the Club to confer with other associations on the subject of improvements in highway bridges, was referred to a committee of three, consisting of H. A. Wheeler, C. H. Sharman, and M. G. Schinke. Mr. J. A. Ockerson presented his resignation as Vice-President, owing to his removal from the city.

Colonel E. D. Meier read a paper on the Prall System of Distributing Heat and Power from a Central Station. This system provides for the use of water heated to a very high temperature and then pumped from the station through pipes. The paper called out an extended discussion.

Engineers' Club of Kansas City.

AN adjourned meeting was held in Kansas City, April 16. The President reported, in brief, the action taken by the delegates at Washington respecting the Cullom Bill, and stated that it would pass the Senate without difficulty, and would probably meet with little opposition in the House.

The discussion of Professor Waddell's pamphlet on Highway Bridges was continued by the reading of several papers, which were afterward verbally discussed by the members present.

Mr. Chanute presented resolutions, which were adopted, for the appointment of a committee to prepare a memorial to the Legislature of the State with a draft of a law providing for inspection of bridges, and that the Secretary be instructed to correspond with other engineering societies to secure co-operation in different States. For this purpose he stated that the reforms desired were to secure the employment of expert engineers; the establishment of legal standards of strength; the forming of a society of responsible bridge-builders, and State inspection of all bridges. The committee appointed under these resolutions is composed of Messrs. Chanute, Waddell, and Breithaupt.

A REGULAR meeting was held in Kansas City, May 7; the following elections were announced: Members: Daniel Bontecou, O. B. Gunn, E. J. Farnsworth, Alexander Potter, M. M. Wells, and William B. Upton. Associate members: H. F. Hill and F. C. Florence.

The Secretary read letters from B. W. DeCourcy, of Independence, Kan., describing some piers and abutments recently erected near there which had failed; also a bow-string girder which was considered unsafe. Photographs of the work were enclosed. The Secretary made some remarks about this masonry, which he had inspected, and also presented tests of the stone.

Mr. Mason gave a brief description of the pavements in use in Kansas City, and spoke especially of the Trinidad asphalt, which he claimed would be hereafter the principal paving material used, on account of its durability and the ease of drainage. Mr. Mason's paper was discussed by members present.

Western Society of Engineers.

A REGULAR meeting was held in Chicago, April 9. The memorial to Congress on the proposed new system of organizing and conducting public works was discussed and amended.

A communication was received from Mr. T. J. Nicholl, Vice-President and General Manager of the Natchez, Jackson & Columbus Railroad, accompanied by a letter from the Pennsylvania Steel Company, advocating the use of rails 33⅓ ft. long as standard, as cars are now 34 ft. After an informal discussion the letters were ordered placed on file.

The Committee on Highway Bridges presented a supplementary report renewing its recommendations as to State inspection of bridges, and adding the following:

"Inasmuch as we think it desirable that any action taken shall be, as far as possible, the joint action of all organizations similar to our own, we recommend, as a step preliminary to such joint action, that the Secretary be instructed to place himself in communication with other local engineering societies, and request from them an expression of opinion on the subject under consideration."

The report was discussed at length by Messrs. Strobel, Williams, Cregier, Gottlieb, Bates, Parkhurst, and others, and finally referred back to committee, with instructions to correspond with other societies, with a view to an expression of opinion and ultimate co-operation.

The question of permanent quarters, and generally of placing the Society upon a more substantial footing, was then taken up. The feasibility of accomplishing material results was generally conceded. The trustees were requested to consider the whole question and report a definite line of action.

The reading of papers was postponed until next meeting.

Montana Society of Civil Engineers.

A MEETING was held in Helena, Mon., April 28, at which Mr. J. H. Farmer read a paper on the Location and Construction of the Wickes Tunnel.

Resolutions in favor of the Cullom Bill for reorganizing the river and harbor service were adopted, and a committee appointed to co-operate with the Council of Engineering Societies.

New England Railroad Club.

THE regular monthly meeting was held at the rooms in Boston, May 9. The first business taken up was the reading of a new constitution and by-laws as drawn up by a committee appointed for that purpose. A discussion arose on the method of dealing with members who had to be dropped owing to non-payment of dues, and it was decided that, before such members could become eligible for future membership, they would have to pay all arrears due. The report was adopted unanimously.

A resolution was adopted endorsing and approving of the action of the President at the last meeting in summarily suppressing remarks that were improper and distinctly out of order. President Lauder, while regretting somewhat that such a resolution was brought forward, returned thanks for the endorsement which it contained.

It was decided to appropriate and pay the usual sum for the services of the Secretary and Treasurer.

The discussion on Steam Heating of Passenger Cars, brought over from the April meeting, was then taken up. The special topic was Radiating Pipes and Valves, which was discussed by Messrs. Chase, Baker, and others present.

Western Railroad Club.

THE regular monthly meeting was held in Chicago, May 16. The subject for discussion being the Proper Size of Axles for a 60,000-lbs. Car. Letters were received from Messrs. Forsyth, Sutherland, and Stevens, and the subject was discussed by Messrs. Barr, Rhodes, Sinclair, and others. At the close of the

discussion the following dimensions were agreed upon to be recommended to the Master Car-Builders' Association as a standard: Length, 6 ft. 11½ in.; between center of journals, 6 ft. 3 in.; size of journals, 8 by 4½ in.; diameter of axle at center, 4⅝ in.; diameter at wheel seat, 5½ in.; diameter of dust-guard bearing, 5 in.

A resolution instructing the Secretary to issue a circular urging railroad officers to attend the meetings was adopted; the Club then adjourned until September.

New York Railroad Club.

THE regular monthly meeting was held in New York, May 17. The subject for discussion was Freight Car Couplers with special reference to the comparative merits of the hook and link-and-pin couplers.

American Society of Mechanical Engineers.

THE Eastern members attending the Nashville meeting left New York in a special car over the Erie line. On their arrival at Cincinnati they were met and entertained by a local committee, of which Mr. W. H. Doane was Chairman.

The meeting at Nashville began on Tuesday, May 8, at 10 A.M., President Horace Lee in the chair.

After the announcement of the new members elected, the first paper on the docket, A Safety Car-Heating System, by H. R. Towne, was read. The paper was discussed by F. R. Hutton, J. L. Gobeille, H. P. Minot, and William Kent, chiefly on the joints and fastenings.

William J. Baldwin's paper, Notes on Warming Railroad Cars by Steam, followed, but elicited no discussion.

Then J. T. Hawkins read a paper on Automatic Regulator for Heating Apparatus. This paper drew forth a long discussion, which tended to show that hot-water systems are largely and successfully used in Canada, and are gradually meeting with increased favor in this country; that a good positive regulator is needed, and that all attempts to regulate the temperature at the radiator were unsuccessful.

Mr. Hawkins then read a second paper on A Plea for the Printing Press in Mechanical Engineering Schools. This paper was discussed by Messrs. Kent, Cobb, Reese, Hutton, Macgruder, Gobeille, and Sweet, and tended to show that in technical schools subjects were selected that would give the greatest amount of training, and that could be carried to a complete end, which could not be done with a subject like the printing press, in the time allowed.

A paper on Estimating the Cost of Foundry Work, by George L. Fowler, was then read, and was followed by a paper on A Short Way to Keep Time and Cost, by H. L. Binsse.

In the afternoon the members visited Fisk University and the plant of the Nashville Iron, Steel & Charcoal Company. Under the patents of Dr. H. M. Pierce, the gases from these charcoal kilns are utilized for the production of wood alcohol, acetate of lime, and some of the tartaric compounds, while the incondensable gases are returned to the kilns or fired in the furnaces.

WEDNESDAY'S SESSION.

The first paper was by R. H. Thurston, on Proportioning Steam Cylinders. The discussion tended to prove the author went into unnecessary refinements, since experience gave as accurate results.

William F. Mattes then read a paper on Connecting Rods. C. C. Collins presented one on A New Method of Inserting and Securing Crank-Pins. The discussion favored the method for the peculiar conditions mentioned, and then turned to the subject of shrinkage.

In the afternoon the Society was present at the laying of the corner-stone of the new Mechanical School of Vanderbilt University, and afterward visited the beautiful farm, Belle Meade, the property of General W. H. Jackson.

In the evening the first paper was by George H. Barnes, on the Effect of Circulation in Steam Boilers on Quality of Steam. Professor Jay M. Whitham described a similar instance on board the U. S. Steamer *Galena*.

Mr. Barnes then read the next two papers: Memoranda on the Performance of a Compound Engine and An Electric Speed Recorder.

The Topical Questions were then discussed.

The principal ones, with the result of the discussions, are mentioned below:

59. What data have you for design of hemp rope transmissions, especially where several parallel ropes replace a flat belt?

The discussion on this was in favor of round rather than V-shaped grooves; one continuous rope instead of a number of single ones, and the use of a long splice.

62. What are the data derived from experience for the design of the paper-covered friction driving-gear used in the Northwest?

They give about as good results as belts of equal width.

66. To what extent does electroplating reduce the temper of highly hardened steel?

None of the members present had investigated this subject, and the discussion turned to the phenomenon of the spontaneous breakage of steel which has been very highly tempered.

THURSDAY'S SESSION.

A paper by J. M. Whitham was presented on Surface Condensers. Professor Hutton showed a piece of brass pipe from a sugar-vapor condenser, from which the zinc had been apparently eaten out. Mr. Nagle said it was a common experience not to use much brass in refineries, and, if necessary, it could be protected by a coating of paraffine.

This was followed by J. S. Coon's paper, Duty Trials of Pumping Engines. Mr. Barnes moved the appointment of a committee to draw up standard rules for pump duty tests. Carried.

F. W. Dean's paper was then read, on The Distribution of Steam in the Strong Locomotive.

The discussion limited itself to the conditions of the trial, it being generally conceded the time was too short, and should not have included the slowing down for a stop and the restarting afterward.

S. S. Randolph's paper was then read, on Strains in Locomotive Boilers, followed by W. L. Clements's on Steam Excavators, and then J. M. Sweeney presented a paper on River Practice of the West, which was listened to with interest.

In the afternoon the members were taken to see the new water reservoir now building just outside the city limits. Its capacity will be 50,000,000 gallons.

At the evening session the first paper was read by H. de B. Parsons, on The Displacements and Area Curves of Fish. This was followed by J. E. Denton's paper on Mechanical Significance of Determination of Viscosity of Lubricants; then F. A. Scheffler, on A Foundry Cupola Experience; A. F. Nagle, on The Best Form of Nozzles and Diverging Tubes; Jacob Reese, on The Tetra-Basic Phosphate; R. H. Thurston, on Large and Enlarged Photographs and Blue Prints; J. Burkitt Webb, on A Persistent Form of Tooth; and William Hewitt, on Wire-Rope Fastenings.

EXCURSIONS.

On Friday the members boarded a special train furnished by the Nashville, Chattanooga & St. Louis Railroad and visited South Pittsburgh, arriving at Chattanooga in the evening. Saturday was spent in seeing the principal manufacturing industries, and in climbing Lookout Mountain. In the evening, after a reception by the Chamber of Commerce, the special train started Northward, and the session closed upon one of the most successful meetings ever held by the Society.

American Water-Works Association.

THE eighth annual meeting was held in Cleveland, O., April 17, 18, and 19, President J. T. Fanning presiding. The first session was held Tuesday morning, and after the transaction of regular business the Society listened to a paper by the President on Water-Supply Treatments and Sources.

At the afternoon session invitations were received to visit works and shops, and a committee was appointed to make suitable arrangements.

The reports of the Executive and Finance Committees were received and accepted.

The Secretary reported that during the last year 44 active, 5 associate, and 1 honorary member had been elected, and that 7 members had been lost by death or resignation, leaving a net increase of 43.

The Society now numbers 210 active, 54 associate, and 1 honorary members.

The last year's total receipts were $1,080, of which a cash balance of $157 remains. This report was approved and accepted.

The death was announced of John Ryle, of Paterson, N. J., and of W. C. Stripe, of Keokuk, Ia. Mr. Stripe was closely identified with the growth of the Society, and was one of its most efficient laborers.

A committee was authorized to prepare obituary memoirs.

Papers were read on Sanitary Protection of Rochester's Water Supply, by Chief Engineer J. Nelson Tubbs; Use of Salt-

Glazed Vitrified Pipe, by S. E. Babcock, and Consumption of Water by Cities and Towns, by H. W. Ayers.

Mr. Y. Nakajima not being present to read his paper on the Water Supply of Tokyo, Japan, it was omitted from the programme, but directed to be printed in the proceedings as appearing with the rest.

The reading of the papers was followed by interesting discussions.

The following officers were elected for the ensuing year: President, A. N. Denman, Des Moines, Ia. Vice-Presidents, J. N. Diven, Elmira, N. Y.; W. G. Richards, Atlanta, Ga.; John W. Hennion, Minneapolis, Minn.; Charles U. Priddy, Leadville, Col.; H. W. Ayres, Hartford, Conn. Secretary and Treasurer, J. H. Decker, Hannibal, Mo.

American Institute of Mining Engineers.

THE spring meeting began, according to announcement, in Birmingham, Ala., May 15, the session being opened by addresses of welcome by several gentlemen representing local organizations. President W. P. Potter, of St. Louis, called the meeting to order and delivered an opening address.

On the first day's session several papers were read, including one by W. M. Bowron on the Process and Cost of Manufacturing Iron at the South Pittsburgh furnaces; and one by A. W. Brainard, of Birmingham, on the Cost of Making Iron and Steel in Alabama; both papers were discussed.

The succeeding days were devoted to excursions to the mines in Birmingham, Bessemer and the adjoining districts, and those of the Lower Cahaba coal fields, interspersed with sessions held for business and the reading of papers. The annual dinner took place on Thursday, May 17.

The business session closed on Saturday, May 19, when the members proceeded over the Georgia Pacific to Anniston, visiting the furnaces of the Woodstock Iron Company and other furnaces and factories in that vicinity. The members remained at Anniston over Sunday, and on Monday were taken to visit the furnaces and ore banks of the Clifton Iron Company, which closed the meeting.

Master Car-Builders' Association.

THE following circulars have been issued by the Secretary from his office, No. 45 Broadway, New York:

ANNOUNCEMENT OF ANNUAL CONVENTION.

The Twenty-first Annual Convention of the Association will be held in the Thousand Island House, at Alexandria Bay, beginning Tuesday, June 12, 1888, at 10 A.M.

Alexandria Bay is in Jefferson County, N. Y., on the St. Lawrence River, near the outlet of Lake Ontario, and 12 miles from Clayton, a terminus of the Rome, Watertown & Ogdensburg Railroad. Boats for Alexandria Bay run in connection with trains arriving at Clayton. Connections are made at Suspension Bridge, Niagara Falls, Rochester, Syracuse, Rome, and Utica, with the Rome, Watertown & Ogdensburg Railroad. Or persons from the East may go to Ogdensburg by the Ogdensburg & Lake Champlain Railroad, and from there by boat to Alexandria Bay. Passengers on the Grand Trunk Railway can connect by steamboat for Alexandria Bay at Kingston, *viâ* Cape Vincent and Clayton, or at Gananoque or Brockville for Alexandria Bay.

The rates at the Thousand Island House, during the Convention, will be $3 per day to members of the Association and their families, and $4 per day to those who are not members. Those who wish to engage rooms in advance should apply to R. H. Southgate, Hotel Brunswick, New York City, and should state for what length of time they will occupy them.

NOTE.—Members who have not answered the circulars of the different committees are urged to do so as promptly as possible.

UNIFORMITY OF THE INTERCHANGEABLE PARTS OF CARS.

Up to the present time the Master Car-Builders' Association has adopted the following standards:

1. Wheel tread and flange.
2. Diameters of chill moulds.
3. Distance between the backs of wheel flanges.
4. Axle.
5. Journal bearing.
6. Journal box.
7. Pedestal.
8. Gauges for wheels and axles.
9. Gauge for guard rails.
10. Brake shoes.
11. Screw threads.
12. Height of draw-bars.
13. Attachments of draw-bars.
14. Dimensions of dead blocks.
15. Attachments for the safety of train men.
16. System of marking cars.
17. Type of automatic coupler.

There is, unfortunately, a tendency, which seems to be inherent in human nature, to depart from established standards of mechanical as well as moral rectitude. In many cases, when parties have nominally adopted the standards of the Association, they have knowingly or unknowingly departed from them to a greater or less degree. In some cases this has been due to ambition to improve on the action of the Association, and in other cases to ignorance or misapprehension of what the standards really are.

Your Committee has been appointed to consider the question, "How can uniformity in the interchangeable parts of cars be obtained?" and to make a report thereon at the next convention of the Association. They therefore request members to reply to the following inquiries and to make any suggestions which will assist the Committee in reporting on the subject.

1. How can railroad companies secure uniformity to the Master Car-Builders' standard in the shape of tread and flange, and the diameters of wheels which they make or buy?

2. How can Master Car-Builders secure uniformity in the distance between the backs of flanges of their own wheels and those which pass over their lines?

3. Are the gauges recommended by the Master Car-Builders' Association for the maintenance of uniformity in wheels and axles the best that can be devised? If not, what kind of gauges would you recommend?

4. How can journal bearings, journal boxes, and pedestals be made interchangeable and kept so?

5. How can brake shoes be made interchangeable and kept so?

6. How can the screws of bolts and nuts be made interchangeable and kept so?

7. In your opinion is it desirable for the Master Car-Builders' Association to adopt uniform non-automatic draw gear, and if so, should the present standard height of draw-bar and dimensions of dead-blocks be adhered to?

8. In the adoption of the Master Car-Builders' standard type of Automatic Coupler, what steps should be taken to secure uniformity and interchangeability in draw-gear of that kind?

9. Besides those already adopted by the Master Car-Builders' Association, what other parts of cars should be standardized by the Association?

As the time before the next meeting is short, members are requested to answer the above questions promptly.

SAMUEL IRVIN,
HARVEY MIDDLETON,
JOHN HODGE,
} Committee.

Replies should be sent to Samuel Irvin, M. C. B., Missouri Pacific Railway, St. Louis, Mo.

NOTICE OF REDUCED FARE FROM THE CONVENTION.

The Trunk Line Association—*outside of the State of New York*—the Central Traffic Association and the Southern Passenger Association have agreed that persons who attend the Master Car-Builders' Convention, from points within the territory covered by these Associations (excepting the State of New York), who pay full fare going to the meeting, shall be returned at one-third the highest limited rate on the above respective Associations' certificates.

Blank certificates will be furnished on application to the Secretary of the Master Car-Builders' Association to persons in the New England States, Pennsylvania, and Maryland. Persons outside of these States, and outside of New York State, can get certificates from ticket agents at points where tickets are purchased. (Certificates will be furnished by the Secretary to parties in the New England States, Pennsylvania, and Maryland, on and after June 1.)

Persons who attend the Convention, from points outside the State of New York, to avail themselves of the concession, must pay full first-class fare going to the meeting, and get a blank certificate to that effect filled in on one side *by the agent of whom they buy their tickets*. They must present this certificate to the proper officer of the Master Car-Builders' Convention at Alexandria Bay for indorsement.

It will be absolutely necessary for each person to obtain a certificate and the signature thereto of the agent of whom the ticket is purchased, to the point where the Convention is held, otherwise the purchaser of a ticket will be unable to obtain the excursion rate returning, and will be obliged to pay full fare both ways. No refund of fares will be made on any account whatever, because of failure of the parties to obtain certificates.

Persons who attend the Convention from points within the State of New York can get excursion tickets from ticket agents for fare and a third without a certificate. Sales will begin on Saturday, June 9, and the tickets will be available for return passage until Monday, June 25, inclusive.

OBITUARY.

OTTO GRUNINGER, who died in New York, April 24, aged 41 years, was a German engineer who first came to this country to examine the construction of the Mt. Washington Railroad, and made a report on that line which practically determined the methods adopted in building the Riggenbach Railroad over the Rigi in Switzerland. He returned to this country some time ago as agent and representative of the Abt rack-rail system of mountain railroads.

SIR CHARLES BRIGHT, who died in London, May 3, aged 56 years, was for all his active life engaged in the telegraphic service. In 1853 he undertook cable work and laid the first line between England and Ireland. Later he was Chief Engineer in charge of the laying of the first Atlantic cable, and was employed in similar work until 1864.

Within the next few years he superintended the laying of cables between the United States and Cuba, and united various parts of North and South America, the West Indies, and other places. In a paper read by him at the Institution of Civil Engineers in 1865, he advocated submarine telegraphs to China and Australia. He was considered a very high authority on all telegraphic questions, and was a prominent member of several scientific societies.

DR. W. W. LAMAN, who died in New York, May 12, aged 61 years, was born in Central New York, and was at one time a physician. He gave up that profession and spent several years in travel in Central Africa, Siberia, and other little-known countries in pursuit of scientific knowledge. On his return he settled in New York City, and became interested in many railroad schemes. At one time he held contingent contracts for over 10,000 miles of railroad. Dr. Laman was, however, inclined to be somewhat visionary, and was not very successful as a promoter, very few of his projects having assumed actual, practical form in his hands, although he possessed great persuasive powers and could always interest others in his plans. His latest schemes were the proposed aqueduct for bringing water from the Adirondack Region to New York City, and the Fulton Street Electric Railroad in New York. The latter is nearly completed, but its opening has been delayed by litigation.

JAMES GILLET, who died at his residence in Brooklyn, N. Y., May 13, was born in Columbus, O., where his parents (who came from Connecticut) had settled a few years before his birth. In 1823, when he was five years old, his parents died, and for 16 years he lived with relatives in Connecticut, working as he grew older on a farm and in a country store. In 1839 he returned to Columbus, and after working in a store for a time, he entered the office of the *Ohio State Journal* as bookkeeper, and also reported for that paper the proceedings of the Legislature of the State. Subsequently he was connected with the editorial department of the paper, and in 1845 he was chosen Secretary of the Board of Control of the State Bank of Ohio. In 1848 he left Columbus on account of his health, and after spending a year in Vermont and six months in Europe went to Florida, where he was for six years in the cotton business. He was then for a time in the lumber business and afterward with Vose, Dinsmore & Co., manufacturers of car springs.

The *National Car Builder* was started by that firm in 1870 under Mr. Gillet's charge as Editor. That charge he retained, under various changes of ownership of the paper, until his death, for he remained at work up to two or three days before the end. Its success was largely due to his intelligent direction and careful supervision of its columns.

The leading traits of Mr. Gillet's character were his strict integrity and conscientiousness; what he said could be entirely relied upon, and no consideration of expediency could induce him to do anything that he did not consider right. He was also a man of wide reading and had much general knowledge, as his friends knew. He had not many intimate friends, but those who knew him best loved him most, and all who were brought in contact with him esteemed him. He leaves no family, his wife and daughter having died several years ago.

THOMAS RUSSELL CRAMPTON, who died at his residence in London, April 19, was born in England in 1816 and studied engineering under the elder Brunel. After several years in subordinate positions he commenced active practice as a Civil Engineer on his own account. In 1848, in the famous discussion over railroad gauges, he took an active part in favor of what is now the standard gauge, opposing the 7-ft. gauge of his old master Brunel.

For some years he devoted himself to the improvement of the locomotive, and in 1847 designed the Crampton engine. An engine of this type was shown at the great Exposition in London in 1851, and for it he received the grand medal. A number of engines of this class were built in England, but in that country they were gradually abandoned. In France, however, the Crampton engine is still in use to some extent. An illustration of a locomotive of this type will be found on another page.

About 1851 Mr. Crampton became interested in telegraph matters, and to his exertions and influence were largely due the laying of the first submarine cable, which was put down under the English Channel from Dover to Calais in 1851. Thenceforward for a number of years his time was largely occupied in telegraph engineering; but he found time to act as consulting engineer for a number of short lines in England, for several of the Turkish railroads, and for the Berlin water-works. His activity was many-sided, however, and he was the inventor of a number of improvements in the manufacture of iron and steel, in brick-making machinery, and in the construction of guns and forts. Although nominally retired from active work for several years, he continued to do as much as his failing health would permit. He was a member of the British Institution of Mechanical Engineers; of the Institution of Civil Engineers; of a number of foreign Societies, and also an officer of the English Society of Telegraph Engineers and Electricians.

PERSONALS.

A. F. NIMS has been appointed City Engineer of Nebraska City, Neb.

W. I. ALLEN has been appointed General Superintendent of the Chicago, Kansas & Nebraska Railroad.

M. A. ORLOPP, JR., has been elected City Engineer of Little Rock, Ark., for the ensuing year.

D. M. WHEELER, of Minneapolis, is now Chief Engineer of the Winona & Southwestern Railroad.

FRANK NICHOLSON, M.E., has been appointed Assayer in charge of the Government assay office in St. Louis.

H. BISSELL has been appointed Chief Engineer of the Boston & Maine Railroad, with office in Boston.

CARY A. WILSON has been appointed Chief Engineer of the East Tennessee, Virginia & Georgia Railroad.

CHARLES S. CHURCHILL is Chief Engineer in charge of the new extension of the Norfolk & Western Railroad to the Ohio River.

S. C. STICKNEY has been appointed Engineer of Maintenance of Way of the Chicago, St. Paul & Kansas City Railroad.

PETER C. HENSEL has been appointed Superintendent of Water Works at Lancaster, Pa., succeeding JACOB HALBACH, resigned.

THE Governor of Kentucky has appointed I. A. SPALDING, A. B. FLEMING, and J. F. HOGAR to be Railroad Commissioners of that State.

STEVENSON TOWLE, for 15 years past in charge of the sewers of New York City, has been appointed a member of the Park Commission of the city.

B. C. LUTHER, Chief Engineer of the Philadelphia & Reading Coal & Iron Company, has succeeded Mr. S. B. Whiting as General Superintendent.

NAVAL CONSTRUCTOR SAMUEL H. POOK has been detached from the New York Navy Yard and placed on waiting orders; he will shortly go upon the retired list.

ASSISTANT NAVAL CONSTRUCTOR JOSEPH H. LINNARD has been relieved from duty in the Bureau of Construction at Washington, and ordered to duty at the Norfolk Navy Yard.

MAJOR N. S. HILL, for many years Purchasing Agent of the Baltimore & Ohio Railroad, resigned June 1, and will engage

in other business. In the reorganization of the company the duties and powers of his office were very much curtailed, and it is understood that this is the reason for his resignation.

ASSISTANT NAVAL CONSTRUCTOR JOHN B. HOOVER has been ordered to duty as Constructor at the New York Navy Yard, and will have special charge of the work on the armored cruiser *Maine*.

D. W. BOWMAN has been appointed Consulting Engineer in charge of the bridges of the Central Railroad of Georgia, with office in Savannah, Ga. He was formerly with the Phœnixville Bridge Company.

G. W. BENTLEY has resigned his position as General Manager of the Jacksonville, Tampa & Key West road, which was largely built through his exertions. He has had a wide and varied experience in railroad work.

DAVID HAWKSWORTH has been appointed Superintendent of Motive Power of the Burlington & Missouri River lines, with headquarters at Plattsmouth, Neb. He will have charge of both the locomotive and car departments.

PROFESSOR M. E. WADSWORTH, Principal of the Michigan Mining School at Houghton, Mich., has been appointed State Geologist for Michigan for one year. He takes the place of the late State Geologist, Charles E. Wright.

A. A. ROBINSON, Second Vice-President of the Atchison, Topeka & Sante Fé Railroad, has been appointed Manager also, and will have charge of the Operating Department as well as of new construction and engineering.

P. F. BRENDLINGER, Chief Engineer of the Pennsylvania Schuylkill Valley Railroad, has resigned that position and goes with Messrs. Brown, Howard & Co., Tarrytown, N. Y., contractors on the Croton Aqueduct, as Chief Engineer.

L. B. WHITING, General Superintendent of the Philadelphia & Reading Coal & Iron Company, resigned May 1. He becomes General Manager of the Calumet & Hecla Copper Mines in the Lake Superior Region of Michigan, with headquarters at Boston.

THE following promotions in the Engineer Corps, United States Army, are announced: CAPTAIN CHARLES E. B. DAVIS to be Major; FIRST LIEUTENANT GEORGE C. DERBY to be Captain; SECOND LIEUTENANT WILLIAM L. SIBERT to be First Lieutenant; SECOND LIEUTENANT EUGENE W. VAN C. LUCAS, late First Artillery, to be Second Lieutenant Corps of Engineers.

R. H. SOULE, on his retirement from the position of General Manager of the New York, Lake Erie & Western Railroad, was presented by the employés of the road with a very handsome watch and chain accompanied by a volume containing a testimonial of respect handsomely engrossed, followed by the signatures of over 4,000 of his friends and well-wishers of the road. At the same time Mrs. Soule was presented with a very handsome cut glass set. Thanks for these gifts were subsequently returned in an appropriate letter. Mr. Soule has started for Europe, where he expects to spend several months in traveling, in order to obtain the rest which he needs.

COLEMAN SELLERS, who several years ago retired from the firm of William Sellers & Company on account of ill-health, has, as his friends will be pleased to hear, so far recovered as to be able to resume active work. Mr. Sellers has been appointed Professor of Engineering Practice in the Stevens Institute of Technology at Hoboken, N. J., and will at once begin his duties there, opening with a course of lectures which is intended to be thoroughly practical. The professorship is a new one, and the Trustees of the Stevens Institute have been exceedingly fortunate in finding a man so thoroughly well fitted to fill the chair in every respect as is Mr. Sellers.

JACOB JOHANN resigned his position as Superintendent of Motive Power on the Texas & Pacific Railroad on June 1. He is one of the best known master mechanics in the country, having been connected with several locomotive works and having filled positions on a number of prominent roads. He has been on the Texas & Pacific for two years, and had previously served on the Chicago & Atlantic; the Wabash, St. Louis & Pacific; the Chicago & Canada Southern and the Missouri Pacific. Mr. Johann has also been a prominent and active member of the Master Mechanics' Association. He served as Vice-President for a year and as Acting President after the death of Mr. Woodcock. He last year declined an election to the presidency. Mr. Johann, we understand, will make his residence at Springfield, Ill., for the present.

NOTES AND NEWS.

A Natural Gas Company.—The Philadelphia Company, operating in Pittsburgh, reports that it is now furnishing natural gas to 791 factories and 22,916 dwellings. For the year ending March 31 the earnings were $1,901,703, and the expenses were $887,061. The dividends (12 per cent.) were $842,627, leaving a surplus of $172,016.

The company's total investment amounts to $9,668,189; its property includes 173 wells, 654 miles of pipe lines, buildings, telephone lines, etc. Besides lands and gas-rights owned in fee, it has gas leases covering 71,444 acres of land.

Blast Pipes for Locomotives.—A recent number of *Industries* gives the following engraving and description of a new variable blast pipe patented in Great Britain by H. Appleby and J. G. Robinson:

"The parts of this apparatus are arranged in such a manner as will allow the blast to be varied at will. The improved blast pipe *A* consists of a central steam nozzle *B*, which communicates with the exhaust of the motor cylinders. The air passage *C* and second steam passage *E* surround the nozzle *B*. The openings *F* for the intake of air are placed at or about the level of the lower row of boiler tubes. The casing *D* is retained in

FIG. 1.

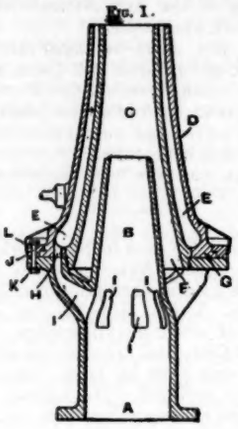
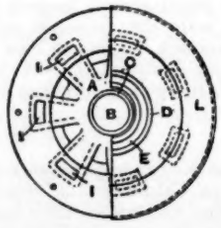


FIG. 2.



its place by the flange *G* and ring *J*, which allow *D* to rotate partially over the lower part of the apparatus. The cap *L* revolves with the upper casing in order to exclude the ashes from its working face. The ports *H* correspond with passages *I*, and lead from the central nozzle *B* to the outer steam passage *E*. When these two sets of ports register with each other, the steam is free to escape by the annular orifice; but upon the external casing being partially rotated, the supply of steam to *E* is more or less intercepted, with the effect of increasing the draft."

A Collision with Dynamite.—A carload of dynamite, on freight train No. 67 of the Philadelphia & Reading Railroad, exploded at Locust Gap, May 5, with terrific force, killing 7 people and wounding 25 others.

The freight train had backed into a siding to allow the passing of the fast line south. When pulling out some of the cars became detached and the train broke in two. The first part waited for the other half to come up, which it did with unexpected violence, the concussion causing the explosion.

Below the road there is a street containing one single dwelling on the north and three double houses on the south. Of these seven nothing now remains, and it was in these that all the deaths occurred. About 100 yards below these buildings there was another row of four double houses which were demolished. Trees near the train were uprooted, while one large tree was blown on top of a freight car.

None of the train hands were injured, although one is said to have been blown a considerable distance.

Railroads in Venezuela.—On March 16 the railroad between Puerto Cabello and Valencia was formally opened by President Hermogenes Lopez.

The Puerto Cabello & Valencia Railroad, as it is called, was commenced a little more than two years ago by Perry, Caruthers & Co., of London, contractors. On April 1 it passed into the hands of the company, of which Mr. W. Mallon is General Manager. The gauge is 3 ft. 6 in.—6 in. wider than the track between La Guayra and Caracas.

The distance is 54 kilometers. Valencia, the southern terminus, is a city of some 40,000 people, and is situated in the heart of one of the richest agricultural regions in the country. In fact, it is admitted that the States of Carabobo and Lara are the first in agricultural development in the entire republic. Another railroad, from Caracas to Valencia, about 300 kilometers in length, is in process of construction by an English company. It is reported that Krupp, of Krupp gun fame, has a concession for still another railroad between the two cities mentioned above.

Another railroad is projected between Puerto Cabello and Aurare, which is not far from the Apure River, one of the principal tributaries of the Orinoco on the north. This is also about 300 kilometers in length.

There is still another line of railroad—already commenced—in this consular district, extending from La Luz to Barquisimeto, a distance of 85 kilometers.—*Report of U. S. Consul D. M. Burke to State Department.*

Baltimore & Ohio Employes' Relief Association.—The following circular from the Baltimore & Ohio Railroad Company explains itself:

"The Act incorporating the Baltimore & Ohio Employés' Relief Association was repealed by an act of the Legislature of Maryland, to take effect on April 1, 1889.

"In order that there may be no apprehension on the part of the members of the Association as to the practical effect of this legislation, it is proper to state that the guarantees of the Baltimore & Ohio Railroad Company for the security of the money in the Savings Fund, and for future deposits, as well as for the rate of interest thereon, remain the same as heretofore.

"The deposits in the Savings Fund on April 1 amounted to $438,166; the Savings Fund Trustees had in their treasury on that date: in cash, $73,893; in B. & O. 5 per cent. mortgage gold bonds, $50,000; while the sum loaned to employés from the Savings Fund for the purpose of building homes, and secured by first mortgages on good real estate, amounted to $317,604.

"The business of the entire Association, including the Building and Savings features, should go on without interruption, and the confidence of its members should not in any way be disturbed by the repeal of the act of incorporation. The Association for the first two years of its existence was conducted without a charter.

"The Baltimore & Ohio Railroad Company and the Committee of Management of the Association will, as early as practicable, take up the question as to whether any modification of the rules and methods of the Association, relating to the Relief Feature, will become necessary on account of the repeal of the charter, and the result made known promptly to its members."

The Pennsylvania Railroad Employés' Relief Fund.—The annual report of the Pennsylvania Railroad Company for 1887 says: "The Employés' Relief Fund, established February 1, 1886, has more than fulfilled the expectations of your management, in the benefits enuring therefrom to such of the employés and their families as have availed themselves of the opportunity thus afforded for relief in cases of sickness, accident, and death. Your Company and affiliated lines contributed during the year $56,701 for operating expenses, and in addition thereto the sum of $1,942 for extra benefits to members of the fund whose disability had continued over 52 weeks, and who were, therefore, no longer entitled to relief therefrom. The amount contributed by your employés was $341,192, the receipts from interest were $5,764, and the contributions by the companies, $58,643, making a total of $405,600, which, added to the balance on hand at the beginning of the year, amounted to $515,407. Out of this fund there was paid to the families of employés in death benefits, and for sickness and accidents, the sum of $266,548, and for expenses $56,701, leaving a balance of $192,158. After deducting therefrom the amount of outstanding unadjusted claims, and setting aside a proper reserve fund to meet liabilities growing out of the increasing age of the members, there remained a net surplus of $111,914. There were 18,744 members of the fund at the close of the year.

"With the view of enabling your employés to safely and conveniently deposit such portion of their earnings as they might desire to accumulate, your Company established, on January 1, 1888, an Employés' Saving Fund, assuming the responsibility of the safe custody and repayment, with reasonable interest, of the moneys deposited. This fund is now in successful operation, and will no doubt, like the Relief Fund, be of value for the purpose indicated."

Chilian Locomotives.—Consul J. W. Romeyn writes from Valparaiso to the State Department as follows: "I have referred incidentally to the building in Chili of certain locomotive engines and cars for the State railroads. I had lately the satisfaction of visiting and inspecting, unofficially, of course, the extensive works of the contractors for the six locomotives, Messrs. Lever, Murphy & Company, at Caleta Abarca, about four miles from this port. Mr. Lever is an Englishman, though formerly a resident of San Francisco. The firm have large capital, have been long established, and have done a great deal of work in repairs on United States vessels of war.

"The wages of their employés, about 450 in number (some 70 per cent. of native birth, the others English, Scotch, and Irish), run as high as $7, Chili money (nearly $4 gold), per day. The locomotives (two still in the shops in a forward state, the four others contracted for having been delivered, the first in December last) are entirely constructed here with the exception of the wheels, which are of English manufacture. The contract price was $40,000 each, about $21,000 gold. Eighteen months was allowed for the construction of all. The general design is the American, with the American truck, and with cylinders on the outside, instead of on the English plan. These cylinders are 17×24 in. Certainly the American engine is much the better adapted to the sharp curves of these mountain roads.

"The machinery used by the constructors for this and other of their metal work is English, that for wood working from the United States. Their steel is imported from England, pig iron for casting from Scotland. Through the kindness of Captain Saukey, an Englishman, but holding the appointment in the Chilian Naval Service of Inspector-General of Machinery, I had the opportunity of inspecting the new steel boilers in construction at the same works for the Chilian corvette *Pilcomayo*, a wooden vessel built in England, and captured from Peru in the late war. The contract price for these two boilers is $52,000 paper currency, about $27,000 gold."

Blast Furnaces of the United States.—The *American Manufacturer* gives its usual monthly table showing the condition of the blast furnaces on May 1 as below:

"The totals are as follows:

	In Blast.		Out of Blast.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	60	11,956	114	13,433
Anthracite	104	30,366	96	24,978
Bituminous	133	80,230	87	45,131
Total	297	122,552	297	83,542

"The table shows that there were 12 more furnaces blowing May 1 than on April 1, and that the increase is confined to the anthracite and bituminous furnaces, there being no change in the number of charcoal furnaces in blast. The gain in the anthracite list is 9 and in bituminous 3.

"The appended table shows the number of furnaces in blast on May 1, 1888, and on May 1, 1887, with their weekly capacity:

	May 1, 1888.		May 1, 1887.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	60	11,956	54	10,819
Anthracite	104	30,366	143	40,873
Bituminous	133	80,230	149	86,822
Total	297	122,552	346	138,514

"This table shows the following changes during the year: Charcoal, increase in number of furnaces blowing, 6; increase in weekly capacity, 1,137 tons. Anthracite, decrease in number of furnaces blowing, 39; decrease in weekly capacity, 10,507 tons. Bituminous, decrease in number of furnaces blowing, 16; decrease in weekly capacity, 6,592 tons. Total decrease of number in blast, 49; total decrease in weekly capacity, 15,962 tons."

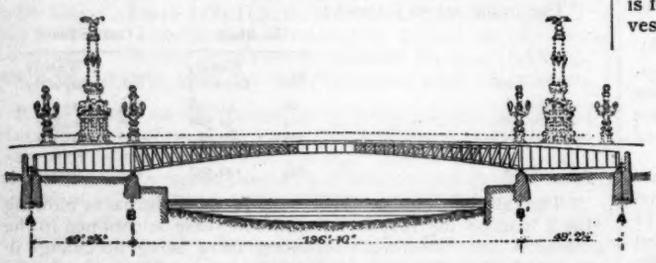
American Steamers for Burmah.—The traffic on the Irrawaddy River, which is the great highway connecting Upper Burmah, which was recently annexed by the English, with the lower province, which has been in their possession for a number of years, is very large. It not only includes the business of the territory bordering on the river, but also that of a large section of country back from it, and some business which is brought from China to Burmah by caravan. This latter, it is

expected, will be largely increased when the proposed railroad from Mandalay is built to the Chinese frontier. The valley of the river is extremely fertile, and has not only a large agricultural population, but also a number of towns and villages, and the Burmese have always been noted for their commercial spirit. The business of the river is at present entirely in the hands of an English company, which runs a number of small steamers of a type not well suited either to the navigation of the river or to the business to be carried; and, furthermore, the number of boats is entirely too small. The company is paying from 50 to 75 per cent. a year on its capital in dividends; but notwithstanding these large profits, it does not seem disposed to increase its investments and the number of steamers.

The Rangoon *Times*, the leading English paper in Burmah, urges that an appeal be made to American capitalists to step in and break the monopoly now held by the Navigation Company, and says that there is no doubt that a number of steamboats of the type used on the Mississippi could find extremely profitable employment. Should such boats be introduced, the *Times* thinks that they would at once take all the business from the English boats on account of their better accommodations, and more suitable arrangements for the traffic, and even should the business be simply divided with the English line, there would be plenty to pay well for the capital required for the enterprise. Should any American steamboat man want to engage in this business, it is probable that reliable information could be obtained from the American Consul at Rangoon, or perhaps in a shorter time by applying to the State Department at Washington.

An Austrian Bridge.—The Stephanie Bridge, which crosses the Danube Canal in Vienna, is of an original and bold design in point of engineering, and a remarkable one in point of architecture and ornamentation. As shown in the cut, it is designed on the principle of a beam fixed at both ends, but more correctly of a continuous girder on four supports, the outer shorter spans being so heavily weighted that, in the most unfavorable case of loading, there is still a pressure of 21 tons on each of the bearings A and A'. An anchorage is nevertheless provided for at both points, to act in case it should be necessary at any time to remove a portion of the balance-weight. B' is a fixed pivot-bearing; while A, B and A' are pivot-bearings on rollers.

The friction of the rollers represents an appreciable force,



which produces bending-moments in the girder and in the masonry block, and it was accordingly introduced into the calculation of the strength of these parts.

The dead-load of the middle span is 466 lbs., and the assumed moving-load 94 lbs. per superficial foot. With these loads, the main-girders are strained with 5.7 tons; the cross-girders with 5.08 tons, and the rivets with 3.81 tons per square inch. A load of 14 tons, on a wheel-base of 11 ft. 6 in. by 5 ft., was also taken into account.

The width of the bridge is 63 ft. 4 in., divided by eight girders, about 7 ft. 9 in. apart. The cross-girders are 5 ft. apart, and on them are trough-irons, laid longitudinally, which support the concrete and wood-block pavement. The balance-weight in the short spans of the girder is constructed of rails and granite blocks.

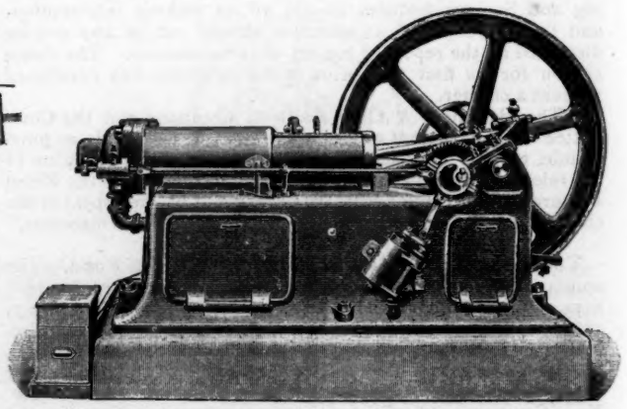
The Engineer is Mr. Oswald Liss, and the Architect, Mr. Otto Hieser.—*Condensed from Allgemeine Bauzeitung.*

Copper Steam Pipes.—The recent accident to the steam pipe of the steamship *Elbe* lends a special interest to the electrolytic process for the manufacture of copper now being practiced by Mr. W. Elmore at Cockermouth. According to the method, such an article as a steam pipe can be produced without weld or joint, and having a tensile strength from 50 to 100 per cent. in excess of first-class brazed pipes. Further, this result can be attained with the use of a very inferior quality of copper, and at a cost which will enable the electrolytically-made article to compete in the market with the customary varieties. Of course there is nothing new in depositing copper in a tubular form, but hitherto such metal has been too brittle to render it reliable for use in circumstances under which it is exposed to great stress. For copying engraved plates, and for the rollers of calico-printing machines, deposited copper has been used with great success, and when it has been thrown down very slowly it has been possible to produce very satisfactory qualities of metal for these purposes. The novelty introduced by Mr. Elmore, however, lies in breaking down the crystals almost immediately they are formed, and pressing them out in a fibrous form in which they are interlaced and matted together. To this end the iron core or mandrel on which the metal is deposited is kept constantly rotating in the bath, and an agate burnisher is slowly wound backward and forward lengthwise of the cylinder as if to put a screw thread upon it. The speeds are so arranged that a layer of copper 0.007 in. thick is deposited between each reciprocation of the burnisher. When the required thickness has been attained the mandrel is lifted out of the bath and placed in a vessel supplied with superheated steam. In a few moments the expansion of the copper detaches it from the iron, and the shell can be stripped off.

Pieces cut from such tubes have been submitted to breaking tests by Messrs. Kirkaldy & Co., Professor Kennedy, and Professor Unwin, and have broken at strains varying from 27 tons to 41 tons per square inch, with an extension varying from 5 to 7½ per cent. in a length of 10 in. The metal can be very easily worked under the hammer, and can be drawn, bent, or compressed without annealing and without any tendency to crack. Specimens polished and submitted to the microscope show that the electrolytic metal has a perfectly compact and homogeneous structure, while drawn copper is a honey-combed mass of crystals, only connected together at points.—*London Engineering.*

The Priestman Petroleum Engine.—Gas engines are used much more in England than in this country, and in some engines recently introduced the gas used is made directly from naphtha or benzine. The latest form of engine makes the gas directly from ordinary petroleum or kerosene, and is known as the Priestman engine, from the name of the maker.

This engine is very simple in construction, having but few working parts. The petroleum from which the motive power is obtained is placed in a closed iron tank inside the foundation. Air is pumped into this tank until a pressure of about 5 lbs. per square inch is obtained. The oil is then mixed with air until it is formed into a vapor, after which it passes into a closed iron vessel, or vaporizer, where it is heated, and from which it is



admitted into the cylinder and ignited by means of an electric spark. This spark is obtained from a small primary battery, capable of doing about 30 hours' work without attention, and which, it is stated, can be renewed at a cost of a few cents. To start the engine it is only necessary to heat the vaporizer for a few minutes, and take a turn or two of the fly-wheel, after which the required temperature is obtained by utilizing the heat from the exhaust products. The cylinder is water-jacketed, the water being contained in the bed-plate of the engine, and circulated by means of a small pump. The engine is self-contained, and after having been started, it runs automatically—that is to say, it prepares its own source of power by pumping air into the petroleum and by atomizing the liquid; it ignites its charge and cools its own cylinder; in fact, it requires no special attention except at long intervals.

It is claimed that this engine can be run at a cost of 1 cent per H.P. per hour, and that it is especially adapted for steam launches, street cars, and other places where space is valuable and where a moderate amount of power is required.